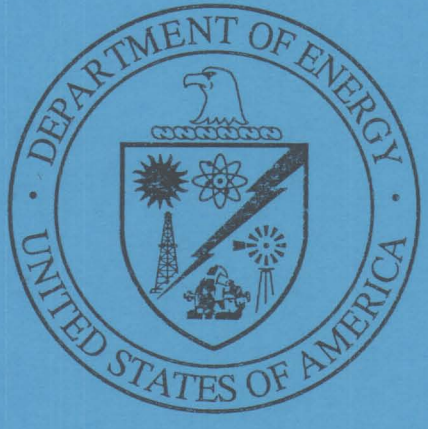
Sandia National Laboratories/New Mexico

PROPOSAL FOR RISK-BASED NO FURTHER ACTION ENVIRONMENTAL RESTORATION SITE 187 SANITARY SEWER SYSTEM OPERABLE UNIT 1302

May 1997

Environmental
Restoration
Project



United States Department of Energy
Albuquerque Operations Office

PROPOSAL FOR
RISK-BASED NO FURTHER ACTION
ENVIRONMENTAL RESTORATION SITE 187
SANITARY SEWER SYSTEM
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Prepared by
Sandia National Laboratories/New Mexico
Environmental Restoration Project
Albuquerque, New Mexico

Prepared for
U.S. Department of Energy

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ACRONYMS

CAB	cellulose acetate butyrate
CEARP	Comprehensive Environmental Assessment and Response Program
COA	City of Albuquerque
COC	constituents of concern
DOE	Department of Energy
DV	data verification/validation
EPA	Environmental Protection Agency
ER	Environmental Restoration
ERDMS	ER data management system
FID	flame ionization detector
GPS	global positioning system
MDA	minimum detectable activity
ml	milliliter
mrem	millirem
MS	matrix spike
MSD	matrix spike duplicate
NEPA	National Environmental Policy Act
NFA	No Further Action
NMED	New Mexico Environmental Department
PCB	polychlorinated biiphenyl
pCi/g	picocuries per gram
PID	photoionization detector
PIP	Program Implementation Plan
POTW	publicly owned treatment works
ppb	parts per billion
PRS	potential release site
Pu	plutonium
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SMO	SNL/NM Sample Management Office
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semi-volatile organic compound

TA	Technical Area
TAL	target analyte list
U	Uranium
UTL	upper tolerance limit
VCM	Voluntary Corrective Measure
VOC	volatile organic compound

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a No Further Action (NFA) decision for Environmental Restoration (ER) Site 187 determined by risk with confirmatory sampling (NFA Criterion 5; NMED et al. 1995).

1.1 ER Site Identification Number and Name

ER Site 187 (herein referred to as the site) is the Sanitary Sewer System, and is included in Operable Unit 1302. The Sanitary Sewer System was listed as Site 187 based on information obtained during the Comprehensive Environmental Assessment and Response Program (CEARP) Phase I interviews. (DOE, 1987). The original ER site name was the Septic Tank Piping for POTW (Active). The ER site name was changed to the TA-I Sanitary Sewer System during the development of the TA-I RFI Work Plans (SNL/NM, 1995).

1.2 SNL/NM NFA Process

The basis for proposing an NFA is thoroughly described in Section 4.5.3 of the Draft *Program Implementation Plan (PIP) for Albuquerque Potential Release Sites* (SNL/NM, 1994a), and in Annex B of the *Environmental Restoration Document of Understanding* (NMED et al., 1995). ER Site 187 is being proposed for a risk-based, confirmatory sampling NFA decision based on NFA Criterion 5. The potential release site (PRS) has been characterized in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use.

1.3 Local Setting

The TA-I sanitary sewer system was constructed between the years 1948 and 1950 (Appendix A, Plate 1-1). The sanitary line has been expanded and modified several times since then. The majority of the system is comprised of vitrified clay pipe ranging from 2 to 8 inches in diameter. The system is designed to collect sanitary and industrial discharges from the buildings in TA-I for treatment at the City of Albuquerque municipal wastewater treatment plant. It currently carries approximately 1 million gal/day, including approximately 60 percent industrial waste; the remaining 40 percent is sanitary effluent (Jones, 1994).

SNL/NM generates industrial wastewater from a variety of laboratories and manufacturing facilities in addition to domestic or sanitary effluents from office buildings (SNL/NM, 1992a). As of 1994, there were six permitted industrial wastewater discharge locations. The City of Albuquerque (COA) requires SNL/NM to comply with limitations and provisions contained in the Sewer Use and Wastewater Control Ordinance for wastewater discharged at these permitted locations (SNL/NM, 1992a). Three permitted locations are subject to National Categorical Pretreatment Standards as described in EPA Effluent Guidelines and Standards, as well as the COA ordinance. National Categorical Pretreatment Standards are regulations promulgated by EPA under the Clean Water Act that specify quantities or concentrations of pollutants and limits on the properties of effluents that may be discharged to a POTW by specific subcategories of industrial users. The three discharge locations subject to National Categorical Pretreatment Standards encompass the following two industrial-type subcategories:

- Metal finishing at Building 841 (Wastewater Discharge Permit 2069D) and Building 878 (Wastewater Discharge Permit 2069H).

- Semiconductor fabrication and manufacturing at Building 858 (Wastewater Discharge Permit 2069G).

Other permitted discharge locations are subject to general effluent limitations specified in the COA ordinance.

Metal finishing is performed in the Plating Laboratory, which occupies approximately 3400 sq ft in Building 841. Until 1991, operations at Building 841 also included circuit board fabrication. Plating Laboratory personnel currently apply metallic and anodic finishes to prototypes; coatings include copper, nickel, anodized aluminum, and precious metals. The wastewater discharged from this facility presently includes process rinse water and sanitary sewage yielding an average combined flow of approximately 100,000 gal/day. Circuit board fabrication operations were discontinued at Building 841 in 1991 and moved to the Process Development Laboratory (Building 878). The discharge from Building 878 has a daily average flow of approximately 3,500 gal. Prototype integrated circuits are manufactured at Building 858, the Microelectronics Development Laboratory. The fabrication process consists of a series of several chemical processes that are common to the semiconductor industry. Effluents consist of neutralized acid waste with approximately 80,000 to 130,000 gal of wastewater discharged per day.

The other permitted discharge locations generally contain sanitary sewage and process streams. Effluent monitored at wastewater monitoring station

WW001, a manhole situated in Tijeras Arroyo approximately one-quarter mile east of Pennsylvania Street and downstream of both TA-I and TA-IV, originates in TA-I and TA-IV and contains both sanitary and process rinse water. This location has an average daily flow of 42,000 gal. Wastewater monitoring station WW006, located near the intersection of O Street and Pennsylvania Avenue, monitors effluent originating from KAFB housing in addition to TA-I wastewater. Daily flow averages approximately 465,000 gal. Effluent at the wastewater monitoring station WW008, a manhole in Tijeras Arroyo one-quarter mile east of Pennsylvania Street and downstream of both TA-I and TA-II, originates from the eastern section of TA-I and TA-II, and contains both sanitary sewage and process rinse streams. Industrial facilities upstream from this monitoring location (Buildings 858 and 878) are monitored independently. Average daily flow is approximately 243,000 gal.

2.0 HISTORY OF THE SWMU

This section provides a summary of the historical information that has been obtained at the site.

2.1 Sources of Supporting Information

Detailed information regarding the site is provided in the following documents:

- *Comprehensive Environmental Assessment and Response Program (CEARP), Phase I: Installation Assessment, Sandia National Laboratories, Albuquerque, New Mexico* [DRAFT] (DOE, 1987).
- *Final RCRA Facilities Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico* (EPA, 1987).
- *Program Implementation Plan for Albuquerque Potential Release Sites* [Draft] (SNL/NM, 1994a).
- *Technical Area I (ADS 1302) RCRA Facility Investigation Work Plan* (SNL/NM, 1995).

2.2 Previous Audits, Inspections, and Findings

The site was first listed as a potential SWMU by the *Comprehensive Environmental Assessment and Response Program (CEARP), Phase I: Installation Assessment, Sandia National Laboratories, Albuquerque, New Mexico* [DRAFT] (DOE, 1987). The sanitary sewer system was listed as ER Site 187 in the CEARP Phase I Report (DOE, 1987) because of deterioration of the sanitary sewer system that was noted during the interviews conducted for the preparation of that report. Some system deterioration was assumed to be a result of normal use; other deterioration was attributed to industrial waste discharges. Based on a verbal agreement between SNL/NM ER Program Management Office and the EPA Region 6, the ER site is limited to those portions of the system where breaks in the lines have been identified and potential COCs have been detected (Doremus, 1994).

2.3 Historical Operations

The sanitary sewer system has been in continuous operation since completion of its construction in 1950. During the past 40 to 50 years, sanitary sewer system discharges have included waste from photographic and printing shops; laboratories; and semiconductor processing, integrated circuit manufacturing, and plating facilities. The general nature of TA-I as a research and development laboratory provided a scenario for use of a multitude of chemicals in generally small quantities. Employee interviews noted that, during the 1950s, 1960s, and 1970s, it was common laboratory practice to handle all hazardous and radioactive wastes in separate receptacles. Wastes deposited in these containers were disposed of at the chemical waste or radioactive waste landfills located in TA-III. If solvents were disposed of in sewer line drains, these releases would have been in very small quantities, such as a 1- to 3-mL rinse of a solvent to clean a circuit board. When the acid waste line (ER Site 226) was abandoned in the mid- to late-1960s, the portion of the line north of I Street was integrated into the sanitary sewer system and any industrial discharges that had been routed to the northern portion of the acid waste line and that were not discontinued at that time became part of the sanitary system effluent.

3.0 EVALUATION OF RELEVANT EVIDENCE

The section summarizes the data collected and evaluated from operational practices, previous investigations, and the RFI investigation.

3.1 Unit Characteristics

The site is an operational system (active) within TA-I. All operational safeguards are overseen by SNL/NM facility personnel. An example of the system safeguards is following the guidelines and procedures of the COA Sewer Use and Wastewater Control Ordinance.

3.2 Operating Practices

Hazardous wastes were not managed or contained at the site. However, hazardous wastes were transferred through the line and may have been released to the surrounding soils from breaks within the lines.

3.3 Presence or Absence of Visual Evidence

No visual evidence of hazardous waste constituents was seen on the surface or in soil samples collected for chemical and radionuclide analyses during the ER Site 187 RFI field investigation.

3.4 Results of Previous Sampling Surveys

Several previous investigations have been conducted in and around the sanitary sewer system. The investigations were in support of building and/or building demolition activities carried out by the facilities organizations at SNL/NM. These investigations have included soil sampling near deficiencies in former Building 814 sewer lines (IT Corp., 1993a); Building 824 sewer lines (IT Corp., 1994a); Building 870 sewer lines (PRC, 1993); and soil sampling near the sewer lines prior to the construction of Building 810 (IT Corp., 1993b,c). Soil sampling was also performed during the VCM that removed those portions of the sanitary sewer lines that served former Buildings 838 and 839 (IT Corp., 1994b,c).

All sample results and documentation associated with these investigations that had previously been conducted were summarized in the TA-I RFI Work Plan (SNL/NM, 1995) and the VCM Report for Buildings 838 and 839 sanitary sewer line removal (IT Corp., 1995). In summary, the data gathered prior to the TA-I RFI indicated that there were no significantly elevated VOC,

SVOC, TAL metals, or tritium values at former Buildings 810, 814, 824, and 870.

A VCM was proposed to the EPA to remove sections of Buildings 838 and 839 uncontaminated sanitary sewer system lines, contaminated acid waste lines, and possible contaminated soils associated with the acid waste lines . In April 1995 authorization was granted by the EPA to conduct the VCM and this action was completed by May 1995 (IT Corp., 1995). Verification samples were collected as part of the VCM to ensure that no contaminated soils remained in the area after the removal of the lines. The results of this sampling verified that all contaminated soil was removed during the VCM (IT Corp., 1995).

3.5 Assessment of Gaps in Information

The RFI field investigation was designed to fully characterize each area of potential concern within ER Site 187. The RFI Sampling and Analysis Plan for this site is provided in Appendix B.

3.6 Confirmatory Sampling

The following subsection provides a summary of the RFI field investigation and the evaluation of the data collected/analyzed during the investigation.

3.6.1 Project Summary

The objectives of the field investigation were to determine the potential vertical and horizontal extent of soil contamination at breaks in the underground lines. The potential constituents of concern (COCs) are radioactive materials, metals, VOCs, SVOCs, and PCBs. These COCs were based on known building activities and processes as well as historical data.

ER Site 187 field investigation started April 20, 1995 and was completed July 20, 1995. The field activities included an in-line camera survey of the sewer lines, drilling soil boreholes, collecting subsurface soil samples for chemical and radionuclide analysis, collecting waste samples for chemical and radionuclide analysis, handling the waste generated during drilling, and surveying borehole locations.

3.6.1.1 Health and Safety Monitoring

A photoionization detector (PID) and/or flame ionization detector (FID) was used to monitor the breathing zone around the drilling and the general background for organic vapors during soil borehole activities. In addition, a

pancake probe was used to monitor the alpha and beta/gamma radiation. The PID and FID readings for the breathing zone and the general area were zero for all soil boreholes. The pancake probe readings ranged from 30 to 80 counts per minute, these readings are within normal background levels.

3.6.1.2 In-Line Camera Survey

During the spring of 1993, an in-line camera survey was conducted in the sanitary sewer system. The resulting data were used to identify pipe deficiencies along the system. This was a major tool for the placement of soil boreholes, as discussed in the Work Plan (SNL/NM, 1995). For this field investigation, an additional in-line camera survey was conducted to reconfirm the exact location of the pipe deficiencies for soil borehole placement. The camera was fitted with a electronic transmitter which could be found with a hand-held utility location finder. The camera crew located the in-line problem and then marked aboveground the location/depth of the pipe deficiency. The survey placement ensured that each location was accurately identified before being sampled.

3.6.1.3 Drilling Program

The drilling program was conducted using a truck mounted Geoprobe® rig and a portable auger. In addition, a hand auger was used at one location between two buildings were the drilling rigs could not gain access. A total of 87 soil borings (TI187-BH-001 through TI187-BH-087) were placed along the sanitary sewer lines (Appendix A, Plate 1-1).

- Soil boreholes TI187-BH-001 through TI187-BH-010, TI187-BH-016 through TI187-BH-019, and TI187-BH-021 through TI187-BH-055 were drilled with the portable auger rig.

- Soil boreholes TI187-BH-011 through TI187-BH-015, TI187-BH-020, TI187-BH-056 through TI187-BH-085 and TI187-BH-087 were drilled with the Geoprobe® rig.

- The hand auger was used for soil borehole TI187-BH-027.

- Soil borehole TI187-BH-086 was not sampled, when the Geoprobe® rig drilled through and broke the sewer line.

Soil borehole numbers TI187-BH-005, TI187-BH-026, TI187-BH-055, TI187-BH-074, and TI187-BH-083 were used to identify duplicate soil samples collected during the project.

3.6.1.4 Soil Collection

Soil samples were collected 18 inches below the base of the sanitary sewer lines at each borehole using the Geoprobe® rig and/or portable auger rig equipped with a 2.5 inch outside diameter by 24 inches long core sampler which was lined with a cellulose acetate butyrate (CAB) sleeve. Samples were collected at a depth ranging from 2.5 to 16 feet below ground surface. Upon removal of the CAB liner from the sampler, one 6-inch section was cut from the liner. This section was sealed with tape and prepared for shipment to the off-site laboratories for VOC analyses. The remaining sample was composited, placed into appropriate containers, and also prepared for shipment to the off-site laboratories for SVOC, PCB, TAL metals, isotopic uranium, plutonium, tritium, and the on-site laboratory for gamma spectroscopy analyses. Usually two sampling runs with the Geoprobe® and auger rig were required to collect enough soil sample for these analyses.

The samples collected and the analysis performed on these samples are provided in Appendix C, Table 1. Eighty-six (includes five duplicates) soil samples were collected and sent to off-site and on-site laboratories.

3.6.1.5 Sample Packaging and Shipping

Soil samples sent to the off-site laboratories for VOC analysis were collected in CAB liners or 125 ml glass bottles; for SVOCs, PCBs, and TAL metals analysis were collected into 500 ml glass bottles, Soil samples sent to the off-site laboratory for tritium analysis were collected into one liter amber glass bottles, and soil samples for isotopic uranium and isotopic plutonium analysis were collected into 500 ml plastic bottles. Soil samples sent to the on-site SNL/NM laboratory for gamma spectroscopy analysis were collected into 500 ml Marenelli beakers. All liner and bottle sets were labeled, sealed with custody tape, and placed in protective bubble-wrap Ziplock bags. The soil samples were placed on ice in the field and cooled to 4°C.

Samples were delivered to the SNL/NM Sample Management Office (SMO) on a daily basis. SMO personnel performed cross-checking of the information on the sample labels against the data on the ARCOCs, and prepared samples for shipment. Samples were shipped by overnight delivery to the off-site laboratories for chemical and radionuclide analyses. The gamma spectroscopy samples were delivered to the on-site laboratory the same day as delivery of corresponding off-site samples to SMO.

3.6.1.6 Survey Soil Borehole Locations

Soil borehole locations were surveyed with global positioning system (GPS) equipment. The GPS data included northing and easting coordinates for each borehole. The soil borehole elevations were estimated using topographic maps.

3.6.1.7 Field Quality Control Samples

Four types of field QC samples were shipped for analysis during the field investigation: field duplicate subsurface soil samples, equipment rinsate blank samples, soil and water trip blank samples, and field blank soil samples. Additional soils were collected for matrix spike/matrix spike duplicate (MS/MSD) analysis. Sample number, date/time of sample event, location, and analysis performed are presented in Appendix C, Table 1.

A total of five field duplicate soil samples were collected and analyzed for the same parameters as the corresponding soil samples. The subsurface soil samples were collected by splitting the CAB sleeve crosswise in two pieces for VOC analysis. For the remaining analyses, soils were removed from the CAB sleeves into a stainless steel bowl and composited, then transferred into appropriate containers.

A total of five equipment rinsate blank samples were collected from deionized water poured over the equipment after decontamination of the sampling equipment. The samples were analyzed for all parameters for which soil samples were analyzed.

Five field blank soil samples were exposed (open jar) to atmospheric conditions around the drilling/sampling operation and analyzed for VOCs only. The field blanks, which consisted of glass bottles filled with clean soils, were supplied by the SMO field office.

Trip blank samples were submitted with each shipment which contained samples for VOC analysis. The aqueous trip blank samples were supplied by the off-site laboratories and the soil trip blanks were supplied by the SMO field office. Thirty-eight trip blanks (29 soil and 9 water) accompanied the sample containers to the field and back to the laboratory.

3.6.2 Data Management

Upon sample shipment to the off-site laboratories, sample information was entered into a database to track the status of each sample. Upon completion

of the laboratory analyses, SMO received analytical results in a summary data report and laboratory QC report.

The data summary (Certificate of Analysis) reports were reviewed by the SMO for completeness and accuracy as required by SNL/NM TOP 94-03 (SNL/NM, 1994b). Data validation was performed using SNL/NM Data Verification/Validation (DV) Level 1 (DV1) and Level 2 (DV2) checklists. SMO submitted the original ARCOCs, the Certificate of Analysis Reports, and the DV1/DV2 review reports to the Environmental Operations Record Center. In addition, the laboratories submitted analytical data in an electronic format for loading into the ER data management system (ERDMS). All chemical analytical data tables generated for this report were downloaded through the ERDMS except gamma spectroscopy data.

3.6.3 Analytical Data Summary

This section discusses the analytical methods and the analytical results of the subsurface soil.

3.6.3.1 Analytical Methods

Soil samples sent to the off-site laboratories were analyzed by the following approved EPA methods: Method 8240/8260 for VOCs, Method 8270 for SVOCs, Method 8080 for PCBs, Method 6010 for TAL metals, and Methods 7471/7470 for mercury. Radionuclide samples were analyzed by the off-site laboratory for isotopic plutonium, uranium, and thorium (waste samples only) using method LAL-91-SOP-0108 and for tritium using method LAL-91-SOP-0067. In addition, the gamma spectroscopy samples were analyzed by SNL/NM approved analytical procedures by the on-site laboratory.

Analytical results for organic compounds listed "J" values for some compounds. A "J" indicates an estimated value for a compound detected at a level less than the reporting limit but greater than the method detection limit. Data results flagged as "J" values are included in the data summary tables used in this report; however, because "J" values may represent false-positive concentrations, care should be used when evaluating these analytical results.

3.6.3.2 Subsurface Soil Sample Results

A total of 86 subsurface soil samples (includes 5 field duplicates) were analyzed for chemical and radionuclide compounds. Table 2 (Appendix C) summarizes the VOC analytical results. Table 3 (Appendix C) summarizes the SVOC analytical results. Table 4 (Appendix C) summarizes the PCB

analytical results. Metals analytical results are provided in Table 5 (Appendix C). Table 6 (Appendix C) summarizes the radionuclide analytical results.

VOC Results

Soil sample results were non-detect or J values for all VOCs except benzene, toluene, methylene chloride, and acetone. Benzene was detected at two locations; TI187-BH-063 (460 ppb) and TI187-BH-064 (1300 ppb). Toluene was detected at one location, TI187-BH-002 (6.4 ppb). Acetone was detected at two locations: TI187-BH-033 (23.5 ppb) and TI187-BH-038 (46.4 ppb) and methylene chloride was detected at one location, TI187-BH-060 (524 ppb). VOCs for which J values were obtained were acetone, methylene chloride, toluene, and xylene.

Trip blank results were non-detect, J values, and/or B values for all VOCs except acetone (four samples), for which values ranged from 20.7 and 38.6 ppb, and methylene chloride (two samples) with values of 17.6 and 350 ppb (Appendix C, Table 2).

Equipment rinsate blank results were non-detect and J and/or B values for all VOCs (Appendix C, Table 2).

Field blank results were either non-detect or J values for all VOCs except for acetone (one sample) at 25.3 ppb (Appendix C, Table 2).

SVOC Results

Soil sample results were either non-detect or J values for all SVOCs except for two compounds; pyrene was detected at 435 ppb and fluoranthene was detected at 463 ppb. Both compounds were detected at the same location, TI187-BH-027.

Equipment rinsate sample results were non-detect for all SVOCs except one detected value (81.9 ppb) of bis(2-ethylhexyl)phthalate (Appendix C, Table 3).

PCB Results

Soil sample results were non-detect for all PCBs except for Aroclor 1260. Aroclor 1260 was detected at one location, TI187-BH-042 (55.4 ppb).

Equipment rinsate sample results were non-detect for all PCBs.

TAL Metal Results

A complete discussion of the TAL metal soil results is provided in Section 3.6.4.1.

Equipment rinsate results for TAL metals were either non-detect or J values except for a low concentrations of aluminum, calcium, iron, sodium, magnesium, lead, nickel, potassium, and zinc.

Radionulcide Results

For soil samples, plutonium (Pu)-238, Pu-233/234, uranium (U)-233/234, U-235, U-238, and tritium were detected with values above reporting limits. The highest detected Pu-238 value was 3.48±0.23 pCi/g. The highest detected Pu-239/240 value was 31.2±1.6 pCi/g. The highest detected value for U-233/234 was 1.39±0.122 pCi/g. The highest elevated value for U-238 was 1.43±0.12 pCi/g. The highest detected U-235 value was 1.51±0.028 pCi/g. The highest detected tritium value was 3730±470 pCi/L.

For equipment rinsate samples, U-235, U-238, and U-233/234 were detected slightly above laboratory reporting limits (Appendix C, Table 6). Isotopic plutonium and tritium were below the laboratory reporting limits.

Gamma spectroscopy results were within background levels. Gamma spectroscopy analytical reports with results are located in the Environmental Operations Record Center.

3.6.4 Statistical Analysis/Evaluation of Concentrations

Statistical analysis of the VOC, SVOC, PCB, isotopic plutonium, and tritium results could not be completed, due to the small number of elevated values from Site 187 data and the lack of detected values for the above mentioned compounds from the TA-I background soil investigation (SNL/NM, 1996).

The chemical and radionuclide data evaluation discussion is provided using the following guidelines: comparing the VOC, SVOC, and PCB analytical results to EPA proposed Subpart S action level for soils (EPA, 1990) and comparing the metal and isotopic uranium analytical results to the background soil data collected during the TA-I field investigation, the site-wide background study for SNL/NM (IT Corp., 1996), and EPA Subpart S action levels for soils (metals only). For updated soil action levels, some values (e.g., zinc) were taken from "Report of Generic Action Level Assistance for the Sandia National Laboratories/New Mexico Environmental Restoration Program" (IT Corp., 1994d). The generic values from this report

were made current for guidance through June, 1994 according to RCRA proposed Subpart S methods. Any soil action level used from that report will be referred to as "generic action level for soils". For TA-I background metal and radionuclide analytical results, the UTL/95th values were developed using the software package Statgraphics (SNL/NM, 1996). In addition, the isotopic plutonium and tritium values were compared to the minimum detectable activities (MDAs).
Based on the soil evaluation (Section 3.6.4.1), a risk assessment analysis was completed on certain chemical and radionuclide data that were above background levels. A summary of that analysis is provided in Section 3.7.

3.6.4.1 Subsurface Soil Evaluation

VOC results were either non-detect or J values except benzene, toluene, acetone, and methylene chloride as summarized in Section 3.6.3.2. The elevated benzene values (460 and 1300 ppb) are below the EPA proposed Subpart S action level of 20,000 ppb. The one toluene value (6.4 ppb), is well below the EPA proposed Subpart S action level of 2,000,000 ppb. The two elevated values of acetone (23.5 and 46.4 ppb) and the one value of methlyene chloride (524 ppb) are well below the EPA proposed Subpart S action levels of 8,000,000 ppb and 90,000 ppb, respectively. In addition, the associated trip blanks also detected elevated values of acetone and methylene chloride. Since the acetone and methylene chloride were detected within ten times their associated trip blank values, the acetone and methylene chloride are considered laboratory contaminants. Although below proposed Subpart S action levels, benzene, toluene, and xylene (J values) were included in the risk assessment analysis.

All samples were either non-detect or J values for SVOCs except for two compounds, pyrene and fluoranthene at one location as summarized in Section 3.6.3.2. The fluoranthene (463 ppb) and the pyrene (435 ppb) concentrations are well below the respective EPA Subpart S action levels of 3,000,000 ppb and 2,000,000 ppb. Although below proposed Subpart S action levels, pyrene and fluoranthene were included in the risk assessment analysis. Although detected as J values, dimethyl phthalate, bis(2-ethylhexyl)phthalate, and phenanthrene were also included in the risk assessment analysis.

All PCB results were non-detect except for one elevated value of 55.4 ppb, which is below the EPA Subpart S action level of 90 ppb. Although below proposed Subpart S action level, PCBs were included in the risk assessment analysis.

TAL metals were compared first to TA-I background levels, then to SNL/NM site-wide background levels, and finally to EPA proposed Subpart S action

levels and/or the generic action level for soils (Appendix C, Table 7). The metals are within TA-I background levels, SNL/NM background levels, and/or Subpart S action levels except for common metals: aluminum, iron, magnesium, potassium, and sodium; and beryllium, cobalt, and thallium. Although iron, magnesium, potassium, and sodium were above background levels, these chemicals are considered essential nutrients and are not considered COCs for this site In addition, beryllium was detected below background levels, but above the proposed Subpart S action level for soils. However, beryllium occurs naturally at higher concentrations in the soils within this geologic region and is not considered a COC for Site 187. Based on the data evaluation and risk assessment criteria (Appendix D), cadmium, cobalt, nickel, selenium, silver, and thallium were included in the risk assessment analysis.

Isotopic uranium (U-235, U-234/234, and U-238) results were compared first to TA-I background levels, and then to SNL/NM site-wide background levels (Appendix C, Table 8). All U-235 and U-233/234 values are within TA-I and/or SNL/NM background levels and are not considered COCs for this site. U-238 was detected above the SNL/NM site-wide background level at two locations with a value of 1.4 pCi/g at each location. Based on isotopic uranium ratio comparisons to TA-I background ranges, U-238 was also not included in the risk assessment (Appendix D).

Analyses for Pu-238 and Pu-239/240 and tritium yield some results that exceeded relevant laboratory MDAs (Appendix C, Table 6). Therefore, isotopic plutonium and tritium were included in the risk assessment analysis.

3.7 Risk Analysis

The following subsections summarize the results of the risk assessment process for both human and ecological risk related factors.

3.7.1 Human Risk Analysis

ER Site 187 has been recommended for industrial land-use (DOE, 1996). A complete discussion of the risk assessment process, results, and uncertainties is provided in Appendix D. Due to the presence of several metals and radionuclides in concentrations greater than background levels, it was necessary to perform a human health risk assessment analysis for the site. Besides metals, any VOCs or SVOCs detected above their reporting limits and any radionuclide compounds either detected above background levels and/or MDAs were included in this assessment. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The risk assessment

report calculated the Hazard Index and excess cancer risk for both an industrial land-use and residential land-use setting. The excess cancer risk from nonradioactive COCs and the radioactive COCs is not additive (EPA, 1989).

In summary, the Hazard Index calculated for chemical compounds is 0.2 and the incremental Hazard Index is 0.1 for an industrial land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA, 1989). The excess cancer risk for chemical compounds is 6 x 10^{-6} and the incremental Hazard Index is 1.2 x 10^{-6} in an industrial land-use setting which is at the lower end of the suggested range of acceptable risk of 10^{-6} and 10^{-4} (EPA, 1989). The incremental excess cancer risk for radionuclides is 5 x 10^{-6} for industrial land-use scenario, which is much less than risk values calculated due to naturally occurring radiation and from intakes considered background concentration values. In addition, the estimated effective dose equivalent for an industrial land-use setting is 1.8 mrem/yr, are well below the standard dose limit of 15 mrem/yr (40CFR196, 1994).

The residential land-use scenarios for this site are provided only for comparison in the risk assessment report (Appendix D). The report concludes that the Site 187 does not have significant potential to affect human health under an industrial land-use scenario.

3.7.2 Ecological Risk Analysis

It is unlikely that activities or COCs at Site 187 have or will have significant impact to ecological risk. TA-I is an industrial complex and has been heavily disturbed by humans for over 50 years. Given the amount of known and potential human intrusion, a great diversity or abundance of nonhuman species has not occurred and is unlikely. Much of the relevant ecological information for TA-I can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM, 1992b).

3.8 Rationale For Pursuing a Risk-Based NFA Decision

Eighty-six soil boreholes were drilled around the site. The data evaluation for the subsurface soils suggests very minimal contamination for VOCs, SVOCs, PCBs, TAL metals, and radionuclide compounds at Site 187. Based on the field investigation data and the human health risk assessment evaluation, a NFA is being recommended for Site 187 for the following reasons:

- No VOCs and radionuclides contamination was detected above background levels during the field screening program.

- Gamma spectroscopy results were within background levels.

- U-235 and U-233/234 results were not detected above its reporting limits and SNL/NM background levels.

- No significant VOCs, SVOCs, and PCBs contamination was detected by the off-site laboratories. In addition, any detected VOC, SVOC, or PCB compounds were below proposed Subpart S action levels for soils.

- No COCs (particularly TAL metals and radionuclides) were present in concentrations considered hazardous to human health for an industrial and/or a residential land-use scenario.

Based on site history, data evaluation, and the risk assessment analysis; further investigation and/or a VCM are not recommended for Site 187.

4.0 CONCLUSION

Based upon the evidence cited above, no potential remains for a release of hazardous and radionuclide waste that pose a threat to human health or the environment. Therefore, ER Site 187 is recommended for an NFA criterion 5. The potential release site has been characterized in accordance with current applicable state or federal regulations, and the available data indicated that contaminants pose an acceptable level of risk under current and projected future land use.

5.0 REFERENCES

40 CFR Part 196, 1994, Code of Federal Register, Radiation Site Cleanup Regulation, rough draft, U.S. Government.

Department of Energy and U.S. Air Force, 1996. "Workbook: Future Use Management Area 2, Sectors 2E and 2G, Areas I-V. " Future Use Logistics and Support Working Group, March 1996.

DOE (U.S. Department of Energy), 1987, "Comprehensive Environmental Assessment and Response Program (CEARP), Phase I: Installation Assessment, Sandia National Laboratories, Albuquerque, New Mexico [DRAFT]. U.S. Department of Energy, September 1987.

Doremus, B., 1994. Telephone Conversation with N. Morlock (EPA) on Building 870 and VCMs. Sandia National Laboratories memorandum to W. Cox, April 1994.

IT Corporation, 1996, "Background Concentrations of Constituents of Concern to the Sandia National Laboratories/New Mexico, Environmental Restoration Project and the Kirtland Air Force Base Installation Restoration Program."

IT Corporation, 1995. "Voluntary Corrective Measure Report Environmental Restoration Sites No. 226 and 187, Former Buildings 838 and 839 Acid Waste and Sanitary Sewer System Lines. Technical Area I, Sandia National Laboratories, New Mexico." December 1995.

IT Corporation, 1994a, "Contamination Assessment Report for Soil Sampling at Building 824." Albuquerque, New Mexico, January 1994.

IT Corporation, 1994b. "Contamination Assessment Report for Buildings 838 and 839." February 1994.

IT Corporation, 1994c. "Report on Phase II Contamination Assessment at Buildings 838 and 839, Technical Area I, Sandia National Laboratories, New Mexico." Albuquerque, New Mexico, August 1994.

IT Corporation, 1994d, "Report of Generic Action Level Assistance for the Sandia National Laboratories/New Mexico, Environmental Restoration Program."

IT Corporation, 1993a, "Contamination Assessment Report for Building 814." Albuquerque, New Mexico, September 1993.

IT Corporation, 1993b, "Field and Laboratory Documentation for Subsurface Soil and Storm Drain Sediment Samples for CNSAC Building 810 Construction Project, Technical Area I, Radiological Analytical Results." Letter report to J. Jones, Sandia National Laboratories, March 1993.

IT Corporation, 1993c, "Field and Laboratory Documentation for Subsurface Soil and Storm Drain Sediment Samples for CNSAC Building 810 Construction Project, Technical Area I, Environmental Chemistry Results." Letter report to J. Jones, Sandia National Laboratories, March 1993.

Jones, J., 1994. "Summary of Camera Survey Performed under Contract AW1497." Sandia National Laboratories, New Mexico, January 1994.

New Mexico Environmental Department (NMED), 1995, "Environmental Restoration Document of Understanding", New Mexico Environmental Department, US Environmental Protection Agency, US Department of Energy, Los Alamos National Laboratory, and Sandia National Laboratories/New Mexico, November 1995.

PCR Environmental Management, Inc., 1993, "Results of Soil Sampling Activities at Building 870, Sandia National Laboratories, Albuquerque, New Mexico, December 1993.

Sandia National Laboratories/New Mexico (SNL/NM), 1996, "TA-I Background Soils Investigation Data Evaluation Report."

Sandia National Laboratories/New Mexico (SNL/NM), 1995, "Technical Area I (ADS 1302) RCRA Facility Investigation Work Plan", Environmental Restoration Program, Sandia National Laboratory, U.S. Department of Energy, Albuquerque Office, February 1995., [Includes: Interview notes and records of telephone conversations with current and retired SNL/NM employees 1 through 51). Communication made from February through June, 1993, as part of ER Program background investigation of TA-I ER Sites. SNL/NM Environmental Operations Record Center maintains these personal communication notes as a controlled document.]

Sandia National Laboratories/New Mexico (SNL/NM), 1994a, "Program Implementation Plan for Albuquerque Potential Release Sites" [DRAFT], Environmental Restoration Program, Sandia National Laboratory, U.S. Department of Energy, Albuquerque Operations Office, September 1993.

Sandia National Laboratories/New Mexico (SNL/NM), 1994b, Verification and Validation of Chemical and Radiochemical Data," TOP 94-03, Rev. 0, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), 1992a. "Wastewater Monitoring Sampling Plan, No. 92-06." Sandia National Laboratories, Albuquerque, New Mexico. October 1992

Sandia National Laboratories/New Mexico (SNL/NM), 1992b. "Site Development Plan." Sandia National Laboratories, Albuquerque, New Mexico.

U.S. Environmental Protection Agency (EPA), 1990, "Proposal Rule, Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities (Subpart S)." U.S. Environmental Protection Agency, 55 FR 30798, July 27, 1990.

U.S. Environmental Protection Agency (EPA), 1989, "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual. US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1987, "Final RCRA Facilities Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico." Prepared by A.T. Kearney, Inc., and Harding Lawson Associates under Contract No. 68-01-7038, April 1987.

Appendix A

ER Site 187 Figure

Appendix B

Section 5.11 of the TA-I RFI Work Plan (SNL/NM, 1995)

5.11 ER Site 187, Sanitary Sewer System

5.11.1 Site Description and History

The sanitary sewer system (Plates 5-7 and 5-8) was constructed between the years 1948 and 1950. The sanitary line has been expanded and modified several times since then. The majority of the system is comprised of vitrified clay pipe ranging in diameter from 2 to 8 in.. The system is designed to collect sanitary and industrial discharges from the buildings in TA-I for treatment at the COA municipal wastewater treatment plant. It currently carries approximately 1 million gal/day comprised of approximately 60 percent industrial waste; the remaining 40 percent is sanitary effluent (Jones 1994).

During the past 40 to 50 years, sanitary sewer system discharges have included waste from photographic and printing shops; laboratories; and semiconductor processing, integrated circuit manufacturing, and plating facilities. The general nature of TA-I activities as a research and development laboratory provided a scenario for use of a multitude of chemicals in generally small quantities. Employee interviews noted that during the 1950s, 1960s, and 1970s it was common laboratory practice to handle all hazardous and radioactive wastes in separate receptacles. Wastes deposited in these containers were disposed of at the chemical waste or radioactive waste landfills located in TA-III. If solvents were disposed of in sewer line drains, these releases would have been in very small quantities, such as a 1- to 3-mL rinse of a solvent to clean a circuit board. When the acid waste line (ER Site 226, Section 5.12) was abandoned in the mid- to late-1960s, the portion of the line north of I Street was integrated into the sanitary sewer system and any industrial discharges that had been routed to the northern portion of the acid waste line and that were not discontinued at that time became part of the sanitary system effluent.

The sanitary sewer system was listed as ER Site 187 in the CEARP Phase I Report (DOE 1987) because of deterioration of the sanitary sewer system that was noted during the interviews conducted for the preparation of that report. Some system deterioration was assumed to be a result of normal use; other deterioration was attributed to industrial waste discharges. For example, a line was corroded between the northeast corner of Building 894 and the northwest corner of Building 870, possibly because of acid discharges from Building 870. Based on a verbal agreement between SNL/NM ER Program Management Office and the EPA Region 6, the ER site is limited to those

portions of the system where breaks in the lines have been identified and potential COCs have been detected (Doremus 1994).

A significant amount of historical information has been compiled regarding the sanitary sewer system during ER review. Based on archival information reviewed and employee and retiree interviews, buildings known or having the potential to have discharged industrial or laboratory wastes are listed in Table 5-28 with the building use and possible types of waste discharged.

5.11.1.1 Wastewater Monitoring Program

SNL/NM generates industrial wastewater from a variety of laboratories and manufacturing facilities in addition to domestic or sanitary effluents from office buildings (SNL/NM 1992f). As of 1994, there were six permitted industrial wastewater discharge locations. The COA requires SNL/NM to comply with limitations and provisions contained in the Sewer Use and Wastewater Control Ordinance for wastewater discharged at these permitted locations (SNL/NM 1992f). Three permitted locations are subject to National Categorical Pretreatment Standards as described in EPA Effluent Guidelines and Standards, as well as the COA ordinance. National Categorical Pretreatment Standards are regulations promulgated by EPA under the Clean Water Act that specify quantities or concentrations of pollutants and limits on the properties of effluents that may be discharged to a POTW by specific subcategories of industrial users. The three discharge locations subject to National Categorical Pretreatment Standards encompass the following two industrial type subcategories:

- Metal finishing at Building 841(Wastewater Discharge Permit 2069D) and Building 878(Wastewater Discharge Permit 2069H).
- Semiconductor fabrication and manufacturing at Building 858 (Wastewater Discharge Permit 2069G).

Other permitted discharge locations are subject to general effluent limitations specified in the COA ordinance.

Metal finishing is performed in the Plating Laboratory, which occupies approximately 3400 sq ft in Building 841. Until 1991, operations at Building 841 also included circuit board fabrication. Plating Laboratory personnel currently apply metallic and anodic finishes to prototypes; coatings include copper, nickel, anodized aluminum, and precious metals. The wastewater discharged from this

Table 5-28. Buildings in TA-I Potentially Discharging Hazardous Materials to the Sanitary Sewer System

Building No.	Use (Duration)	Possible Wastes Discharged
643	Standards Laboratory	Plutonium oxide
802	Photo Laboratory (1948-1989) in basement south wing	Photochemicals, acids
	Print Shop	Unknown
	Neutron generator laboratory on 2nd floor east wing	Tritium
805	Laboratories (1959-present), metallographic examinations, wet grinding, and wet polishing	Cyanide mixtures and compounds disposed to drains; solvents, alcohols, tritium, depleted uranium (DU), selenium, neutron activation products, etching solution of phosphoric acid and U-238
806	NTS Diagnostics, laboratories (1961-present)	Solvents, alcohols
807	Laboratories (1966-?), explosives formulation work	HNS, PETN, azides, styphnates, disposal of organics into drains; solvents, alcohols, HE
808	Weapon Training (1948-?), Mechanical Assembly, Chemical Storage, and Shop Areas	Unknown
809	Component and weapon assembly (explosives stored)	DU, solvents (alcohol, acetone, TCE), lithium tetraboride (or borate?), explosives
823	Chemical Tracer Laboratory (geology tracer studies)	Radioactive tracers in acid solution (1989—60 gal/yr), solvents
818	Calibration and counting facility	Gamma and neutron sources stored (Co-60, Cs-137, Cf-252, Pu-239, Am-241, Ra-226)
828	Transducer Evaluation & Calibration (1946), Weapons Production, Metallurgy, Print Shop/Graphic Arts	Unknown
829	Graphic Arts (1948-1992)	Unknown
830	Bioassay Laboratory	Photographic solutions, chromic acid
835	Warhead (weapons) assembly	Alcohol, acetone, DU, beryllium, class C explosives (phosphate and nitrite residuals), tritium
838	Seismic Lab & Safety Office (1946); Printed Circuits; Standards Laboratory	Solvents, heavy metals
839	Instrument Repair & Property Management (1946)	Solvents, metal alloys
840	Machine Shop (1951); ceramics shop in northeast corner	Lead oxide powder in drains

Table 5-28. (page 2 of 2)

Building No.	Use (Duration)	Possible Wastes Discharged
841	Plating Shop, Foundry, Printed Circuits	Electroplating solutions discharged to drains, large amounts of water; lead castings, ferric chloride, copper solutions, strippers, paints and solvents
844	Radiation Source Laboratory	Tritium
T-855	Development Lab & Toxic Machine Shop (1946)	Beryllium, heavy metals, DU
860	Environmental Testing Lab (1949)	
863	Document Vault (1950); Motion Picture & Film Processing (1951)	Waste photographic processing solutions, solvents, silver
867	Storage of classified radioactive materials	
868	Equipment calibration	Lead-shielded radioactive standards
869	Toxic machine shop (1980-1990)(milling of toxic, hazardous, and nonhazardous materials)	Acetone, beryllium, lead, arsenic, cadmium
870	Microprocessor production facility	Hydrofluoric acid, sodium hydroxide, solvents; acid spills and discharges to storm and sanitary
872	Equipment storage room, light laboratory, radiofrequency facility	Unknown
874	Motor pool: service station (1946-1968), dispatch office (1968-1980s), offices (1980s-present)	Petroleum hydrocarbons, solvents
875	Motor pool: automotive shop (1950-present)	Petroleum hydrocarbons, solvents
876	Motor pool: interior, vehicle maintenance and repair (1940s-present). Exterior: wash/steam clean pit (built 1965; routed to sanitary sewer system in early 1990s)	Interior: Petroleum hydrocarbons, solvents. Exterior: water from cleaning vehicles, waste oil, battery fluid, other wastes associated with vehicle maintenance
880	Field Test Organization Laboratory (testing of neutron generators for use at the NTS)	Tritium
888	Component Testing laboratory	
891	Energy Technology Lab/Offices (1984); Neutron Tube Development Facility (1985-1989)	Alcohol, acetone, tritium
892	Weapon assembly and disassembly	DU, acetone, toluene; hydrogen sulfide neutralizing system, lost small amounts of sodium hydroxide
894	Synthetic oil coal liquifaction, fabrication shop, shipping/receiving	Silver nitrate, potassium hydroxide ammonium hydroxide
895	Chemical & Flammable Materials/Gas Cylinder Storage Building (1950)	Chemical & flammable materials

facility presently includes process rinse water and sanitary sewage yielding an average combined flow of approximately 100,000 gal/day. Circuit board fabrication operations were discontinued at Building 841 during 1991 and moved to the Process Development Laboratory (PDL; Building 878). The discharge location at PDL is currently permitted by the COA and has a daily average flow of approximately 3,500 gal. Prototype integrated circuits are manufactured at Building 858, the Microelectronics Development Laboratory. The fabrication process consists of a series of several chemical processes that are common to the semiconductor industry. Effluents consist of neutralized acid waste with approximately 80,000 to 130,000 gal of wastewater discharged per day.

The other permitted discharge locations generally contain sanitary sewage and some process streams. Effluent monitored at the wastewater monitoring station WW001, a manhole situated in the Tijeras Arroyo approximately one-quarter mile east of Pennsylvania Street and downstream of both TA-I and TA-IV, originates in TA-I and contains both sanitary and process rinse water. This location has an average daily flow of 42,000 gal. Effluent streams monitored at the wastewater monitoring station WW006, located near the intersection of O Street and Pennsylvania Avenue, contains effluent originating from KAFB housing in addition to TA-I wastewater. Daily flow averages approximately 465,000 gal. Effluent from the wastewater monitoring station WW008, a manhole in the Tijeras Arroyo one-quarter mile east of Pennsylvania Street and downstream of both TA-I and TA-II, originates from the eastern section of TA-I and contains both sanitary sewage and process rinse streams. Industrial facilities upstream from this monitoring location (Buildings 858 and 878) are monitored independently. Average daily flow is approximately 243,000 gal.

5.11.2 Previous Investigations

This section summarizes data collected at the TA-I Sanitary Sewer system which can be used to help develop the sampling and analysis plan strategy for the RFI at this site.

5.11.2.1 Building Investigations

In support of building demolition activities carried out by the facilities organizations at SNL/NM, investigations for potential contaminant releases to soils from sanitary, storm drain, and acid waste lines have been performed at several buildings in TA-I. Soil sampling investigations were conducted near several buildings scheduled for demolition to investigate potential contamination of soils as a result of possible leakage through cracks and offset joints in sanitary sewer lines that served the

buildings under investigation. Through June 1994, six investigations have been carried out. A synopsis of these investigations is provided below.

5.11.2.1.1. Building 814

For much of its occupancy, Building 814 was used for thermal battery fabrication. Chemicals and metals used included calcium chromate, lithium chloride, potassium chloride, potassium perchlorate, sulfuric acid, potassium hydroxide, sodium hydroxide, lithium hydroxide, hydrochloric acid, carbon tetrachloride, trichloroethene, aluminum, brass, iron, lead, lithium, mercury, nickel, potassium, stainless steel, and tin. From 1975 until the building was vacated in 1993, the organization responsible for the publication of the *Sandia Lab News* occupied a portion of the building; photochemicals were used by this group. Another smaller portion of the building was used as apprentice training shops and classrooms (machinist and electronics), although no hazardous materials were identified for those activities.

In July 1993, Building 814 and adjacent soils were investigated. Four samples (including one duplicate) were collected near deficiencies in the building sewer line. The samples were collected from below the level of the sewer line (3 to 4 ft bgs) and within 18 in. laterally of selected cracks and offset joints in the lines and submitted to an off-site analytical laboratory for VOC, SVOC, and TAL organics analyses, to SNL/NM Radiation Protection Measurements Department for gamma spectroscopy, and to an off-site radiological laboratory for tritium analysis. No constituents were detected above action levels derived in accordance with the methodology in the proposed Subpart S (EPA 1990b) and SNL/NM soil background metals and radionuclide concentrations (IT Corp. 1994b) and no additional soil investigation was required (IT Corp. 1993c). Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time.

5.11.2.1.2. Building 824

Building 824 was constructed in 1946 and was used continuously as a mailroom until 1992 when the building was scheduled for demolition and vacated. Site inspection documentation did not contain evidence of any chemical or radioactive material use in the building.

In November 1993, soils adjacent to Building 824 were investigated. Nine samples (including one duplicate) were collected near deficiencies in the building sewer lines. The samples were collected from below the level of the sewer line (4 to 5 ft bgs) and within 18 in. of selected cracks and offset joints in the lines and submitted to an off-site analytical laboratory for VOC, SVOC, and TAL organics analyses, to SNL/NM Radiation Protection Measurements Department for gamma spectroscopy, and to an off-site radiological laboratory for tritium analysis.

No constituents were detected above action levels derived in accordance with the proposed Subpart S (EPA 1990b) methodology and SNL/NM soil background metal and radionuclide levels (IT Corp. 1994b) and no further soil investigation was required (IT Corp. 1994d). Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time.

5.11.2.1.3. Buildings 838 and 839

Buildings 838 and 839 were constructed in 1946 and permanently vacated in 1993. Historical records for Building 838 indicated that the building was used as a motor pool, for offices and as a small-scale laboratory. Small quantities of hazardous materials (solvents and heavy metals) were used at the building; it was uncertain whether any test included radioactive materials. Building 839 was used most recently as offices, but historical records indicated that it previously had been used for instrument repair and as a circuit print shop. At various times, the building housed a materials research laboratory, a glass shop, the laboratory laundry, and the laboratory cafeteria. Acids, solvents, metal alloys, photoresist chemicals, epoxies, and uranium were noted as potential COCs. Past acceptable operational practices may have allowed disposal of small quantities of waste into building drains. Waste materials also may have been placed in open containers and set on a loading dock west of Building 839 to await removal by waste management personnel.

Sampling was carried out at Buildings 838 and 839 in December 1993 and January 1994. The buildings were investigated jointly because they are located adjacent to one another. The investigation included collection of soil samples adjacent to the sanitary sewer lines that served the buildings. Two laterals of the acid waste line (ER Site 226) serving Building 839 were also sampled; the results of that investigation are described in Section 5.12. Six soil samples (including one field duplicate) were collected at the Building 838 sanitary sewer lines and two were collected for investigation of the

sanitary sewer lines at Building 839. The samples were collected from below the level of the sewer line (3 to 5 ft bgs) and within 18 in. laterally of selected cracks and offset joints in the lines and submitted to an off-site analytical laboratory for VOC, SVOC, PCBs (one Building 839 sanitary sewer sample) and TAL organics analyses, to SNL/NM Radiation Protection Measurements Department for gamma spectroscopy, and to an off-site radiological laboratory for tritium analysis.

At Building 838, no VOCs or SVOCs were detected above the actions levels derived in accordance with the methodology given in the proposed Subpart S (EPA 1990b). Of the metals detected, only beryllium was above the proposed Subpart S action levels (EPA 1990b). Beryllium was detected in all six samples at or above the action level of 0.2 mg/kg but below the SNL/NM soil background level of 0.785 mg/kg (IT Corp. 1994b) (values ranged from 0.20 to 0.44 mg/kg). All of the soil samples contained one or more radionuclide activities above the action level specified in the SAP for the building, but the detected radionuclides exist in the natural environment at similar concentrations and are not considered as having man-made origins. Since no constituents were detected above action levels except as noted, a baseline risk assessment was considered unnecessary at the time.

At Building 839, for those samples collected to evaluate soils near the sanitary sewer line, no metals, VOCs, SVOCs, or PCBs were detected above proposed Subpart S action levels (EPA 1990b) or SNL/NM soil background levels (IT Corp. 1994b). However, these soil samples contained one or more radionuclide activities above the action level specified in the SAP for the building, but the detected radionuclides exist in the natural environment at similar concentrations and are not considered as having man-made origins. While the soils near the sewer lines did not require further investigation, samples from the acid waste line (ER Site 226) indicated the need for additional investigation, which is described in Section 5.12 (IT Corp. 1994e). Since no constituents were detected above action levels except as noted, a baseline risk assessment was considered unnecessary at the time.

A VCM is being proposed to the EPA to remove uncontaminated sewer lines at Buildings 838 and 839 as well as sections of contaminated acid waste lines at Building 839. The VCM Plan, Waste Management Plan, and Sampling and Analysis Plan are presently in draft and are anticipated to be ready for regulatory review in the second quarter of fiscal year 1995. Verification samples will be collected as part of the VCM to ensure that no contaminated soil remains after the removal of the lines.

5.11.2.1.4. Building 870

Building 870 was constructed in 1960 for use as a material reclamation building. In 1975, it was converted into a microelectronics design laboratory. Since 1975, the building has been used for semiconductor production, and has had numerous expansions and modifications. The building has been a facility for various operations including clean-rooms, packaging, failure-analysis laboratories, electrical test areas, chemical storage areas, semiconductor manufacturing support, and offices. Since 1992 it has been used as office space. From 1975 until 1992 a variety of chemicals were used in manufacturing operations. The sewer laterals connected to Building 870 received both sanitary sewage and process related wastewater from the microelectronic manufacturing process when it was operational. Analytical data on the wastewater effluent from this facility are not available, but historical information on production related chemical use and the corrosion in piping documented during the in-line camera survey of the sewer indicate that the presence of chemical constituents in wastewater discharge was likely (PRC 1993a).

During soil sampling conducted in October 1993 near Building 870, three sites were sampled near sanitary sewer lines. A total of four samples was collected: two were collected from below the level within 18 in. laterally of the sewer lines and two were collected below a lateral at two depths (5 to 6 ft bgs and 10 to 11 ft bgs) at the third site. The samples were submitted to an off-site analytical laboratory for VOC, SVOC, and total RCRA metals (*i.e.*, total TC metals) analyses.

No VOCs or metals were detected above action levels derived in accordance with the proposed Subpart S methodology (EPA 1990b) or SNL/NM soil metals background levels (IT Corp. 1994b). One sample was found to contain detectable levels of several polynuclear aromatic hydrocarbon compounds (PAH), which might be considered indicative of asphalt or roofing tar in the sample. Additional tar samples collected at the site showed similar PAH compounds (PRC 1993c). It was resolved that the PAH compounds were possibly related to roofing materials. Since risk-based calculations indicated that, for an industrial setting, the levels of PAH compounds detected were acceptable, no further investigation of SVOC compounds at Building 870 was required by the EPA (Blejwas 1994) and a baseline risk assessment was considered unnecessary at the time.

5.11.2.1.5. Building 810 (CNSAC Project)

Prior to the construction of Building 810, Center for National Security and Arms Control (CNSAC), five existing structures and the associated sewer system required demolition and removal. The uses of the buildings varied widely and information indicated that research laboratories were housed in some of the structures during portions of their occupancy. The sanitary sewer system received effluent from the Buildings 630, 632, 634, MO 42-55, T1-6, T38, MO 121, MO 216-218, and MO 79/80. Effluent from the buildings was primarily sanitary waste, but because the site audit could not determine the complete histories of the buildings, a complete list of the potential COCs could not be produced for the investigation. Information suggested that the sewer system in the area of the CNSAC also received hazardous waste from other buildings in TA-I (PRC 1993d).

In February 1993, 20 environmental soil samples and two duplicate samples were collected adjacent to sanitary sewer lines in the CNSAC area. All the samples were analyzed for VOCs, SVOCs, and total RCRA metals by an off-site analytical laboratory. Selected samples (12, based upon sample screening results) were analyzed for radiological parameters including gamma spectroscopy(potassium-40, cobalt-60, cesium-137, radium-226, and radium-228), tritium, isotopic uranium, and isotopic plutonium by an off-site radiological laboratory.

No VOCs were detected in concentrations which exceed the risk-based action levels derived in accordance with the methodology in proposed Subpart S (EPA 1990b). Elevated SVOC compounds, primarily PAH compounds, were detected in one sample collected adjacent to a sewer line near I Boulevard and were attributed to asphalt or road tar. All samples contained some metal compounds, but no levels exceeded the risk-based actions levels derived in proposed Subpart S (EPA 1990b) or SNL/NM background metals concentrations (IT Corp. 1994b). Three radionuclides (radium-228, uranium-234, and uranium-238) were detected but the levels are well within the background ranges of each. Plutonium-238 was detected in two samples at values of 0.03 $\pm$ 0.020 pCi/g and 0.016 $\pm$ 0.018 pCi/g; comparison data are unavailable for plutonium isotopes. All other radionuclide levels were less than the background levels. Radiological results for uranium, plutonium, gamma spectroscopy, and tritium were designated as "unremarkable" by the Radioactive and Mixed Waste Department (IT Mar 1993; IT Corp. 1993d,e). Since no constituents were detected above action levels except as noted, a baseline risk assessment was considered unnecessary at the time.

5.11.2.2 Camera Survey

In the spring of 1993, an in-line camera survey was performed on an estimated 60,000 ft of the sanitary sewer line breaks and cross-connections to the storm drain system. In the fall of 1993, a second camera survey identified additional breaks in sewer lines serving buildings of potential concern and abandoned lines. These investigations are described in detail in Section 5.10. Several deficiencies were identified and evaluated (Plates 5-7 and 5-8). The following criteria have been used to define pipe deficiencies (Jones 1994):

- A minor crack is a hairline crack which shows no sign of an open void in the pipe material.
- A moderate crack has a visible void in the pipe wall and may have an offset of pipe material at the crack.
- A severe crack was noted in cases where soil was visible through the opening in the pipe.
- A slight offset joint has a deflection of approximately 1/4 in. or less.
- A moderate offset joint has an exposed gasket or a joint deflection greater than 1/4 in.
- A severe offset joint has soil visible through the offset joint.
- Where there are roots in the lines, particularly in clay pipe, there is the potential for a moderate crack.
- Where not specified, offset joints are slight breaks.
- Where an offset joint is noted to be cracked, the break is moderate.
- Where there is either a joint with offset, a joint with roots, a possible old repair, or a cracked joint, the break is moderate.
- Where there is a broken pipe, a bad joint, an old repair, or a hole in the pipe, the break is severe.

Pipe deficiencies and break locations are shown on the plates. Deficiencies or breaks are shown as slight, moderate, or severe by line weight around, and shading within, the keyed note symbol in both the legend and the plate. Keyed notes which do not indicate a pipe deficiency or breaks are screened back. Keyed notes which pertain to the acid waste line (ER Site No. 226, Section 5.12) are marked by an "A".

5.11.3 Nature and Extent of Contamination

Some information on the nature of the waste discharged to the sanitary sewer system has been obtained through archival information (*e.g.*, wastewater monitoring and miscellaneous sampling results) and employee interviews. Additional data have been gathered in conjunction with the facilities projects described above. Based on known building activities and processes and data collected to date, the effluent through the years may have contained radionuclides as well as metals, VOCs, SVOCs, and PCBs. To date, no contamination associated with releases from sanitary sewer line deficiencies have been detected in soils underlying the piping.

5.11.4 Conceptual Model

The conceptual model for the sanitary sewer system is based on available information on system usage and the line breaks located by the in-line camera survey. Based on known building activities, processes carried out at SNL/NM, and data collected to date, the potential COCs include radioactive materials as well as metals, VOCs, SVOCs, and PCBs. Deficiencies in lines that have carried industrial or laboratory waste provide a pathway for the waste to the surrounding soil.

Based on available data and knowledge of system use, the potential COCs would not be expected to migrate substantially from the release site, nor be present in concentrations which pose a risk to human health or the environment. There is little potential for lateral contaminant migration. In most cases the lines are buried 4 to 8 ft bgs. There is no grade or local topography, nor surface runoff or overland flow which would contribute to lateral contaminant migration. There is the potential for vertical migration through the vadose zone. Because the system has been in continuous use since SNL/NM began operation, the flow in the line has created an hydraulic head to drive the flow through the vadose zone. The COCs present in the soil could also migrate vertically through the vadose zone with infiltrating precipitation; however, that migration mechanism is limited because of the extensive paving in TA-I.

In order to develop a strategy for investigating releases from the sanitary sewer, a model of migration of contaminants through the vadose zone was assumed. The sanitary sewer system is designed to flow half full. Therefore, there should not be a release from a crack in the sanitary line above the flow line. Cracks or other deficiencies in the line are considered a point source of a release. Because

of the low potential for lateral migration, any release is assumed to migrate downward in a conical zone. The release is assumed to spread at approximately a 45 degree angle from the vertical as it migrates vertically.

The potential COCs in the sanitary sewer line are similar to those in the Storm Drain System except that bases have been excluded. Information on the mobility and persistence of the potential COCs is given in the Storm Drain Conceptual Model, Subsection 5.10.4.

A release from the sanitary sewer would not pose a direct risk to human health and the environment. The affected area lies a minimum of 4 ft bgs and, in many areas, is 8 ft bgs. Unless the line is accessed for construction purposes, there should be no direct contact with the affected soil via inhalation, ingestion, or dermal exposure. If construction is required, proper precautions will be taken to protect site workers. The potential release source and the local aquifer are separated by 500 ft, limiting the potential risk to potable water quality.

Potential corrective measures at the sanitary sewer system are primarily limited to excavation and off-site treatment or disposal. Because of the wide range of contaminants that may be present and the probable distribution of COCs at break locations, *in situ* and on-site treatment technologies are not considered technically or economically feasible at this time. However, on-site treatment may be feasible if a large soil volume is affected. If data collected indicate that, because of the areal and vertical extent of COCs, the volume of soil to be generated from releases along the lines warrant it, on-site treatment technologies will be evaluated.

5.11.5 Sampling Plan

The sampling strategy selected for the sanitary sewer system is designed to characterize potential releases from the system at the break locations identified by the in-line camera survey.

General DQOs for TA-I RFI are specified in Section 4.3. Specific DQOs for the sanitary sewer system investigation include:

- Determining if any VOCs, SVOCs, metals, PCBs, and/or radionuclides have been released to the soil within 18 in. laterally of an identified line break.

- Producing data of adequate quality (Level III) for all shallow subsurface samples at each break location under investigation so that risk calculations may be performed for an individual break location.

- Characterizing the vertical extent of any COCs detected above action levels near the sewer lines by collecting samples from deep soil borings for analysis (Level II and Level III).

- Producing data of adequate quality (Level III) for 20 percent of deep borehole samples so that risk calculations may be performed and corrective measures may be evaluated.

The DQOs will be achieved through implementation of the sampling strategy outlined below. If contaminants are detected in the soil samples at concentrations above the action levels, additional samples (*i.e.*, borehole) will be collected. Analytical Levels II and III will be required for analytical procedures identified under this plan. Data will be collected during surface and shallow subsurface soil sampling and deep soil boring investigations.

5.11.5.1 Shallow Subsurface Soil Near Sanitary Lines

5.11.5.1.1. Data Collection

Soil samples will be collected adjacent to the breaks identified by the in-line camera survey (Plates 5-7 and 5-8). In many cases, the breaks are clustered around a line segment. Where samples are clustered, a streamlined sampling approach will be taken. Soil will be sampled at one location, selected to be representative of the potential worst case release to surrounding soil. The streamlined approach has been adopted based on the homogenous nature of the sewage. The sewage and any COCs which have entered the system would be the same along a given line or section of line that received discharge from the same source. COCs present would be diluted with discharge from additional lines downstream of each connection and at the confluence of lines. The in-line camera survey identified lines from buildings where potentially hazardous constituents were discharged to the sanitary sewer and off-set joints or line breaks from which hazardous constituents may have been released to soil. Given the break density and severity designations, the criteria listed below comprise the bases for the selected sample locations.

- Where two or more breaks are located along 100 ft of pipe, the most severe and most upgradient break will be sampled. For example, just south of Building 806 three breaks were identified within 100 ft of one another (Plate 5-7; Nos. 34, 35, and 37); the central break is severe and has been chosen for sampling.

- Where two keyed notes of the same severity were located downgradient of a building connection, the keyed note legend was consulted to select the location having the greatest potential to be the source of a release. For example, east of Building 806, two breaks (Plate 5-7; Nos. 28 and 29) were both identified as moderate breaks. Both were cracked joints, but the No. 28 break was both the most upgradient and had roots visible and so is considered as having the greater potential for a release and has been chosen as a sample location.

- Where there are two or more slight breaks within 100 ft of pipe, the most upgradient break will be sampled;

- Where five or more severe breaks are clustered along 100 ft of pipe, the most upgradient break and that break nearest a downgradient connection will be sampled (*i.e.*, two breaks will be sampled if more than four severe breaks are located within 100 ft); and

- Where a break is over 100 ft from another break location, the break location will be sampled.

One soil sample will be collected by auger within 18 in. adjacent to the line at the locations shown in (Plates 5-7 and 5-8) for field screening and lithologic logging. Soil for laboratory analysis will be transferred from the sampling device to the sample containers immediately upon collection. Additional soil will be collected for screening and logging and then containerized as IDW. The sample locations are indicated on the figures using bolded circles around the keyed note symbol on the plates.

5.11.5.1.2. *Analytical Parameters*

Table 5-29 at the end of this subsection for the shallow subsurface samples lists the environmental, QA/QC, and waste management samples. All shallow subsurface (line) samples collected near or below sanitary sewer lines will be analyzed at an off-site laboratory (Level III) for VOCs, SVOCs, PCBs, total TAL inorganics, isotopic uranium, isotopic plutonium, and tritium, and at an on-site laboratory (Level II) by gamma spectroscopy. Thirty percent of the collected soil samples (chosen on a random basis) will be analyzed for hexavalent as well as total chromium. Field screening for VOCs using a PID or FID and for alpha and beta/gamma radiation using alpha scintillation and Geiger-Mueller pancake probes will be conducted as samples are collected.

5.11.5.2 Borehole Investigation

5.11.5.2.1. Data Collection

At break locations where the shallow subsurface analytical data exceed risk-based action levels derived in accordance with the methodology presented in the proposed Subpart S (EPA 1990b) and SNL/NM background metals and radionuclide concentrations, boreholes will be drilled and additional soil samples will be collected (see Section 4.1.2). At those break locations where the shallow subsurface sampling does not indicate the presence of contamination, boreholes will not be drilled. One borehole will initially be drilled approximately 18 in. downgradient from a hot shallow subsurface sample location. The vertical extent of potential contamination will be determined using field screening and on-site laboratory analyses. Three additional boreholes will be located radially around the initial borehole, with one located downgradient from the initial borehole, adjacent to the pipe. The distance of these boreholes from the central borehole will be dependent upon the vertical extent of potential contamination: the distance should equal approximately one-half the vertical extent of the potential contamination, to a maximum of 25 ft. The distance and location of the radial boreholes may be modified based on available screening techniques, site clearance, and access.

At each borehole location, a hollow-stem auger will be used to collect samples for field screening (if available for COCs detected), lithologic logging, and for laboratory analysis (Level II or III). Borehole sampling will be initiated at the depth of the shallow subsurface sample. Samples will be collected at 5-ft intervals from 5 to 50 ft, at 10-ft intervals from 50 to 100 ft, and at 20-ft intervals at depths greater than 100 ft. The boreholes will be drilled until two consecutive samples are determined to be uncontaminated by means of field screening or on-site analysis, as appropriate, or to the depth limits of the drilling method. Sampling will then be terminated.

Split samples will initially be collected at the two shallowest 5-ft intervals. One split from each depth will be sealed, labeled, and set aside for possible off-site laboratory analysis. The other split will be logged for lithology and field screened or analyzed at the on-site analytical laboratory as appropriate for the COCs under investigation. The samples will also be surveyed for beta/gamma radiation using a Geiger-Mueller pancake probe. If no COCs are detected, then these two 5-ft samples will be considered uncontaminated and sent for confirmatory off-site analysis. If one of the first two samples is contaminated, then the borehole will be advanced and sampled at the intervals described above until two consecutive intervals are determined to be uncontaminated. To meet the objectives described

above, at least 20 percent of the samples will be submitted for off-site verification analysis, including the sample showing the highest screening value (to characterize the nature of the COCs) and one sample from each of the two deepest uncontaminated sample intervals (to characterize the vertical extent of COCs). Other samples may be chosen by the field geologist, using professional judgment, to be representative of the sample set. Core not submitted for laboratory analysis will be disposed of as IDW.

If boreholes are determined to be necessary, they will be located as described above. For planning purposes, borehole depth is estimated to be approximately 100 ft bgs, but the depth may be extended based on the field screening results. Actual depth of vertical sampling may vary according to field conditions and the equipment capabilities. At least three environmental samples will be collected for Level III analysis from each borehole as well as additional QA/QC samples.

5.11.5.2.2. *Analytical Parameters*

Table 5-30 at the end of this subsection is an example table; listing the environmental, QA/QC, and waste management samples for a single borehole. Samples collected from the deep borings will be analyzed only for the parameters detected in the shallow subsurface samples. Field screening for VOCs using a PID or FID and for alpha and beta/gamma radiation using alpha scintillation and Geiger-Mueller pancake probes will be conducted as samples are collected.

Table 5-29. ER Site 187: Shallow Subsurface Soil Sample Identification and Analytical Specifications

ER SITE 187 : (Sanitary Sewer System)					FIELD SCREENING (a)					ON-SITE LAB ANALYSES (b) (c) (d)			OFF-SITE LAB ANALYSES (d) (e) (f)														
FIELD NUMBER Assign Bar-Coded Sample Number In Field	SAMPLE ID (g) See Plates 5-7and 5-8 for Locations	SAMPLE METHOD (e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rinsate Blank, Trip Blank, Duplicate, etc.)	SAMPLE DEPTH (ft)	VOCs	TPH	SOIL pH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (8240)	TPH (8015)	SVOCs (8270)	PCBs (8080)	TAL INORGANICS (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (h)	TCLP ORGANICS (1311/8270/8240)	HEX CHROMIUM
	BH-001	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-002	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-003	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-004	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-005	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-006	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-007	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-008	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-009	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-010	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-011	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-012	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-013	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-014	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-015	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-016	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-017	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-018	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-019	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-020	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-021	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-022	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-023	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-024	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-025	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-026	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-027	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-028	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-029	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-030	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X

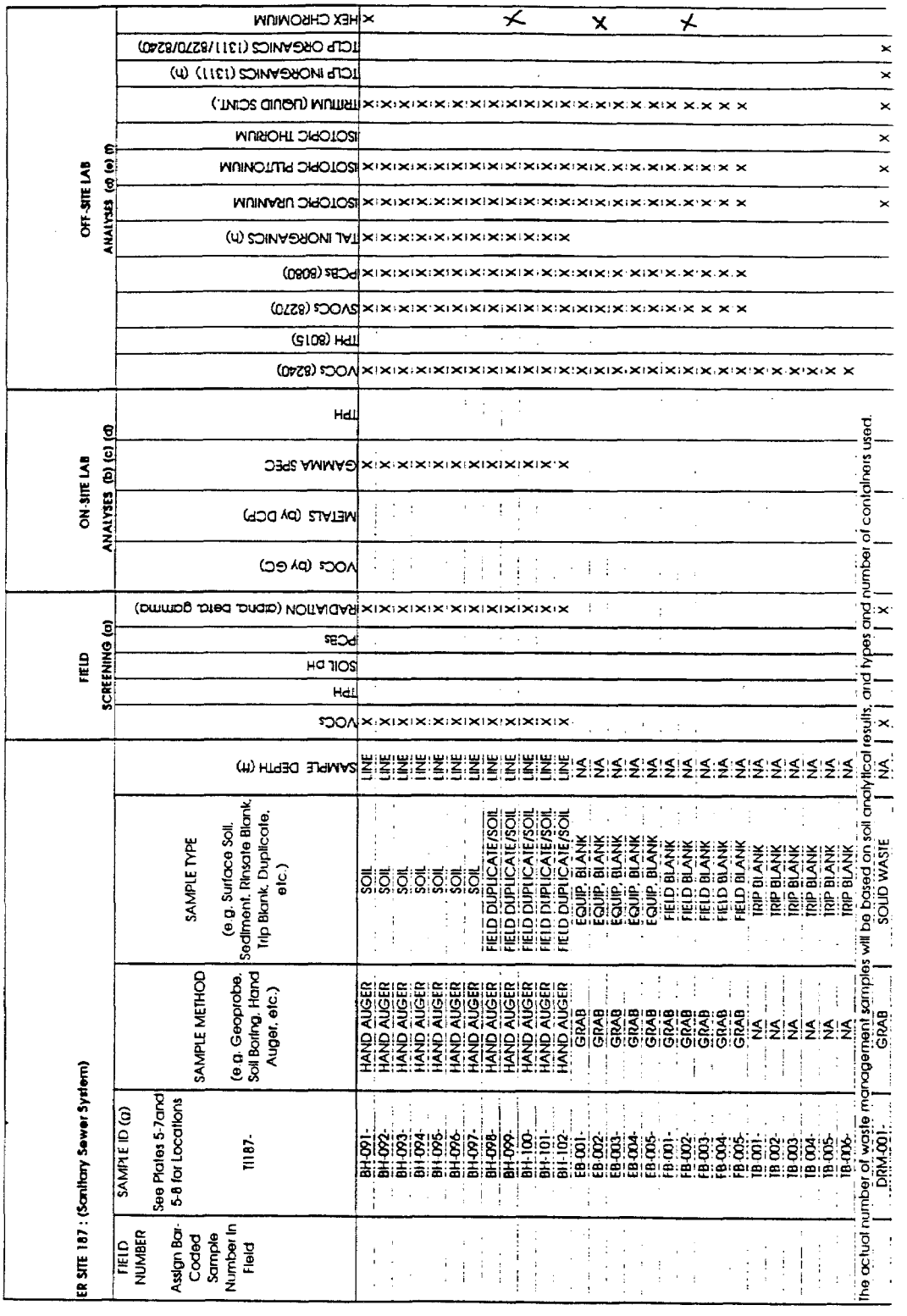
ER SITE 187 : (Sanitary Sewer System)

FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD	SAMPLE TYPE	SAMPLE DEPTH (ft)	FIELD SCREENING (a)					ON-SITE LAB ANALYSES (b) (c) (d)				OFF-SITE LAB ANALYSES (d) (e) (f)											
Assign Bar-Coded Sample Number in Field	See Plates 5-7and 5-8 for Locations 11187-	(e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	(e.g. Surface Soil, Sediment, Rinsate Blank, Trip Blank, Duplicate, etc.)		VOCs	TPH	SOIL pH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (8240)	TPH (8015)	SVOCs (8270)	PCBs (8080)	TAL INORGANICS (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (h)	TCLP ORGANICS (1311/8270/8240)	HEX CHROMIUM
	BH-031-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-032-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-033-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-034-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-035-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-036-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-037	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-038-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-039-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-040-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-041-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-042-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-043-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-044-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-045-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-046-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-047-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-048-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-049-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-050-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-051-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-052-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-053-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-054-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-055-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-056-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-057-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-058-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			X
	BH-059-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			
	BH-060-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X		X			

Table 5-29. (page 3 of 5)

ER SITE 187 : (Sanitary Sewer System)					FIELD SCREENING (a)						ON-SITE LAB ANALYSES (b) (c) (d)				OFF-SITE LAB ANALYSES (e) (f)														
FIELD NUMBER Assign Bar-Coded Sample Number In Field	SAMPLE ID (g) See Plates 5-7and 5-8 for Locations TI187-	SAMPLE METHOD (e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rinsate Blank, Trip Blank, Duplicate, etc.)	SAMPLE DEPTH (ft)	VOCs	TPH	SOIL pH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (8240)	TPH (8015)	SVOCs (8270)	PCBs (8080)	TAL INORGANICS (7)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (7)	TCLP ORGANICS (1311/8270/8240)	HEX CHROMIUM
	BH-061-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-062-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-063-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-064-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-065-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-066-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-067-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-068-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-069-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-070-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-071-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-072-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-073-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-074-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-075-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-076-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-077-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-078-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-079-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-080-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-081-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-082-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-083-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-084-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-085-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-086-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-087-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-088-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-089-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X
	BH-090-	HAND AUGER	SOIL	LINE	X				X			X		X				X	X	X		X						X

Table 5-29. (page 4 of 5)



ER SITE 187 : (Sanitary Sewer System)					FIELD SCREENING (a)					ON-SITE LAB ANALYSES (b) (c) (d)			OFF-SITE LAB ANALYSES (d) (e) (f)											
FIELD NUMBER Assign Bar-Coded Sample Number In Field	SAMPLE ID (g) See Plates 5-7and 5-8 for Locations TI187-	SAMPLE METHOD (e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rinsate Blank, Trip Blank, Duplicate, etc.)	SAMPLE DEPTH (ft)	VOCs	TPH	SOIL pH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (8240)	TPH (8015)	SVOCs (8270)	PCBs (8080)	TAL INORGANICS (7)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (7)	TCLP ORGANICS (1311/8270/8240)	HEX CHROMIUM
	BH-091-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-092-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-093-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-094-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-095-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-096-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-097-	HAND AUGER	SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-098-	HAND AUGER	FIELD DUPLICATE/SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-099-	HAND AUGER	FIELD DUPLICATE/SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-100-	HAND AUGER	FIELD DUPLICATE/SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-101-	HAND AUGER	FIELD DUPLICATE/SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	BH-102-	HAND AUGER	FIELD DUPLICATE/SOIL	LINE	X				X			X		X		X	X	X	X	X	X	X	X	X
	EB-001-	GRAB	EQUIP. BLANK	NA	X									X		X								
	EB-002-	GRAB	EQUIP. BLANK	NA	X									X		X								
	EB-003-	GRAB	EQUIP. BLANK	NA	X									X		X								
	EB-004-	GRAB	EQUIP. BLANK	NA	X									X		X								
	EB-005-	GRAB	EQUIP. BLANK	NA	X									X		X								
	FB-001-	GRAB	FIELD BLANK	NA	X									X		X								
	FB-002-	GRAB	FIELD BLANK	NA	X									X		X								
	FB-003-	GRAB	FIELD BLANK	NA	X									X		X								
	FB-004-	GRAB	FIELD BLANK	NA	X									X		X								
	FB-005-	GRAB	FIELD BLANK	NA	X									X		X								
	TB-001-	NA	TRIP BLANK	NA	X									X										
	TB-002-	NA	TRIP BLANK	NA	X									X										
	TB-003-	NA	TRIP BLANK	NA	X									X										
	TB-004-	NA	TRIP BLANK	NA	X									X										
	TB-005-	NA	TRIP BLANK	NA	X									X										
	TB-006-	NA	TRIP BLANK	NA	X									X										
The actual number of waste management samples will be based on soil analytical results, and types and number of containers used.																								
	DRM-001-	GRAB	SOLID WASTE	NA	X				X															

ER SITE 187 : (Sanitary Sewer System)					FIELD SCREENING (a)					ON-SITE LAB ANALYSES (b) (c) (d)				OFF-SITE LAB ANALYSES (d) (e) (f)												
FIELD NUMBER Assign Bar-Coded Sample Number in Field	SAMPLE ID (g) See Plates 5-7and 5-8 for Locations	SAMPLE METHOD (e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rinsate Blank, Trip Blank, Duplicate, etc.)	SAMPLE DEPTH (ft)	VOCs	TPH	SOIL DH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (8240)	TPH (8015)	SVOCs (8270)	PCBs (8080)	TAL INORGANICS (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (h)	TCLP ORGANICS (1311/8270/8240)	HEX CHROMIUM
	11187-			TOTAL SAMPLES	103				103			102		118		112	112	102	113	113	1	113	1	1	31

Total Samples: Field Screening = 103; On-site Lab = 102; Off-site Lab = 119

Notes

(a) Analytical level I Data: Field screening methods and rationale are discussed in the text

(b) Analytical level II Data: On-site Lab sample container volume/type requirements will be determined by the on-site laboratory during mobilization

(c) On-site lab analytical methods will be determined at a later date.

(d) All geochemical laboratory samples will be preserved on ice unless otherwise noted

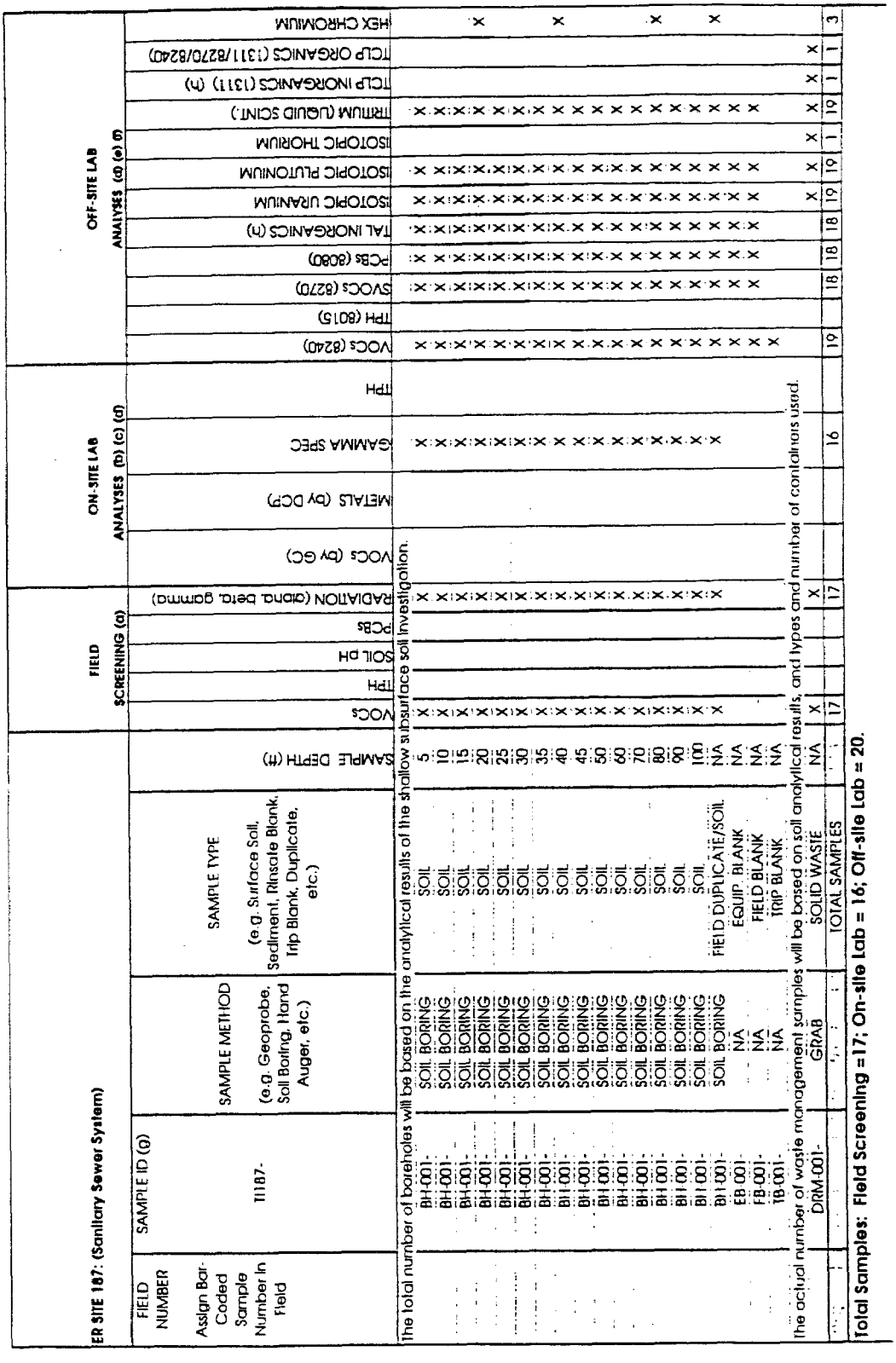
(e) Analytical level III Data: Consists of duplicates of 20% of the on-site laboratory analytical samples.

(f) Off-site Lab sample container volume/type requirements for soil and water will be determined by the Sample Management Office during mobilization

(g) The Sample ID contains information regarding location, matrix, depth, etc.; this sample identification scheme is described in Section 4.4.

(h) Inorganics analytical methods include 6010 and 7000 series analysis.

Table 5-30. ER Site 187: Borehole Soil Sample Identification and Analytical Specifications



ER SITE 187: (Sanitary Sewer System)					FIELD SCREENING (a)					ON-SITE LAB ANALYSES (b) (c) (d)				OFF-SITE LAB ANALYSES (d) (e) (f)										
FIELD NUMBER Assign Bar-Coded Sample Number in Field	SAMPLE ID (g) 1187-	SAMPLE METHOD (e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rinsate Blank, Trip Blank, Duplicate, etc.)	SAMPLE DEPTH (ft)	VOCs	TPH	SOIL pH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (8240)	TPH (8015)	SVOCs (8270)	PCBs (8080)	TAL INORGANICS (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (h)	TCLP ORGANICS (1311/8270/8240)	HEX CHROMIUM
The total number of boreholes will be based on the analytical results of the shallow subsurface soil investigation.																								
	BH-001-	SOIL BORING	SOIL	5	X				X			X		X		X		X	X	X	X			X
	BH-001-	SOIL BORING	SOIL	10	X				X			X		X		X		X	X	X	X			
	BH-001-	SOIL BORING	SOIL	15	X				X			X		X		X		X	X	X	X			
	BH-001-	SOIL BORING	SOIL	20	X				X			X		X		X		X	X	X	X			X
	BH-001-	SOIL BORING	SOIL	25	X				X			X		X		X		X	X	X	X			
	BH-001-	SOIL BORING	SOIL	30	X				X			X		X		X		X	X	X	X			
	BH-001-	SOIL BORING	SOIL	35	X				X			X		X		X		X	X	X	X			X
	BH-001-	SOIL BORING	SOIL	40	X				X			X		X		X		X	X	X	X			
	BH-001-	SOIL BORING	SOIL	45	X				X			X		X		X		X	X	X	X			
	BH-001-	SOIL BORING	SOIL	50	X				X			X		X		X		X	X	X	X			X
	BH-001-	SOIL BORING	SOIL	60	X				X			X		X		X		X	X	X	X			
	BH-001-	SOIL BORING	SOIL	70	X				X			X		X		X		X	X	X	X			X
	BH-001-	SOIL BORING	SOIL	80	X				X			X		X		X		X	X	X	X			
	BH-001-	SOIL BORING	SOIL	90	X				X			X		X		X		X	X	X	X			
	BH-001-	SOIL BORING	SOIL	100	X				X			X		X		X		X	X	X	X			X
	BH-001-	SOIL BORING	FIELD DUPLICATE/SOIL	NA	X				X			X		X		X		X	X	X	X			
	EB 001-	NA	EQUIP. BLANK	NA										X		X		X	X	X	X	X	X	X
	FB 001-	NA	FIELD BLANK	NA										X		X		X	X	X	X	X	X	X
	TB 001-	NA	TRIP BLANK	NA						X				X										
The actual number of waste management samples will be based on soil analytical results, and types and number of containers used.																								
	DRM-001-	GRAB	SOLID WASTE	NA	X				X															
			TOTAL SAMPLES		17				17			16		19		18	18	19	19	19	19	1	1	3

Total Samples: Field Screening = 17; On-site Lab = 16; Off-site Lab = 20.

Table 5-30. (page 2 of 2)

ER SITE 187: (Sanitary Sewer System)					FIELD SCREENING (a)						ON-SITE LAB ANALYSES (b) (c) (d)				OFF-SITE LAB ANALYSES (d) (e) (f)											
FIELD NUMBER Assign Bar-Coded Sample Number In Field	SAMPLE ID (g) TI187-	SAMPLE METHOD (e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rinsate Blank, Trip Blank, Duplicate, etc.)	SAMPLE DEPTH (ft)	VOCs	TPH	SOIL pH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (8240)	TPH (8015)	SVOCs (8270)	PCBs (8080)	TAL INORGANICS (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (h)	TCLP ORGANICS (1311/8270/8240)	HEX CHROMIUM

Notes:

(a) Analytical Level I Data: Field screening methods and rationale are discussed in the text.
(b) Analytical Level II Data: On-site Lab sample container volume/type requirements will be determined by the on-site laboratory during mobilization.
(c) On-site lab analytical methods will be determined at a later date
(d) All geochemical laboratory samples will be preserved on ice unless otherwise noted.
(e) Analytical Level III Data: Consist of duplicates of 20% of the on site laboratory analytical samples
(f) Off-site Lab sample container volume/type requirements for soil and water will be determined by the Sample Management Office during mobilization
(g) The Sample ID contains information regarding location, matrix, depth, etc.; this sample identification scheme is described in Section 4.4
(h) Inorganics analytical methods include 6010 and 7000 series analysis.

Appendix D

ER Site 187: Risk Assessment Analysis Report

ER SITE 187: RISK ASSESSMENT ANALYSIS

I. Site Description and History

The sanitary sewer system was constructed between the years of 1948 and 1950. The sanitary lines have been expanded and modified several times since their original construction. The majority of the system is comprised of vitrified clay pipe ranging in diameter from 2 to 8 inches. The system is designed to collect sanitary and industrial discharges from the buildings in Technical Area I (TA-I) for treatment at the City of Albuquerque (COA) municipal wastewater treatment plant. It currently carries approximately 1 million gallons/day comprised of approximately 60 percent industrial waste; the remaining 40 percent is sanitary effluent.

The sanitary sewer system was listed as Environmental Restoration (ER) Site 187 based on reports that the system had received constituents of concern (COCs) from various activities and breaks in the lines. The potential COCs are radioactive materials, metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). These COCs were based on known building activities and processes and historical data.

II. Risk Assessment Analysis

Risk assessment of this site includes a number of steps which culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include:

Step 1.	Site data are described which provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways by which a representative population might be exposed to the COCs are identified.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations. Potential intake calculations are also applied to background screening data.
Step 4.	Data are described on the potential toxicity and cancer effects from exposure to the COCs and associated background constituents and subsequent intake.

Step 5.	Potential toxicity effects (specified as a Hazard Index) and cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with standards established by the United States (U.S.) Environmental Protection Agency (USEPA) and U.S. Department of Energy (USDOE) to determine if further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Discussion of uncertainties in the previous steps.

II.1 Step 1. Site Data

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the ER Site 187 Data Evaluation Report and the No Further Action Proposal (NFA). In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. Chemicals that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (USEPA 1989a). Both radioactive and nonradioactive COCs are evaluated. The nonradioactive COCs evaluated include both metals and organics.

II.2 Step 2. Pathway Identification

ER Site 187 has been designated with a future land-use scenario of industrial (USDOE, 1996)(see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion. The inhalation pathway for both chemicals and radionuclides is included because of the potential to inhale dust and volatiles. Direct gamma exposure is also included in the radioactive contamination risk assessment. No contamination at depth was determined and therefore no water pathways to the groundwater are considered. Depth to groundwater at Site 187 is approximately 550 feet. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered to not be significant. No intake

routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

PATHWAY IDENTIFICATION

Chemical Constituents	Radionuclide Constituents
Soil Ingestion	Soil Ingestion
Inhalation (Dust and volatiles)	Inhalation (Dust and Volatiles)
Plant uptake (Residential only)	Plant uptake (Residential only)
	Direct Gamma

II.3 Steps 3-5. Calculation of Hazard Indices and Cancer Risks

Steps 3 through 5 are discussed in this section. These steps include the discussion of the tiered approach in eliminating potential COCs from further consideration in the risk assessment process and the calculation of intakes from all identified exposure pathways, the discussion of the toxicity information, and the calculation of the hazard indices and cancer risks.

The risks from the COCs at ER Site 187 were evaluated using a tiered approach. First, the maximum concentrations of COCs were compared to TA-I specific background screening levels using 95th upper tolerance limits (UTLs) or percentile values (Sandia National Laboratories/New Mexico [SNL/NM], 1996). If a maximum concentration of a particular COC exceeded the TA-I specific background screening level, then the COC was compared to the SNL/NM background screening level for this area (IT, 1996). If a SNL/NM specific screening level was not available for a constituent, then a background value was obtained, when possible, from the U.S. Geological Survey (USGS) National Uranium Resource Evaluation (NURE) Program (USGS, 1994). For uranium isotopes, if a maximum concentration exceeded the SNL/NM background screening level, the isotopic ratios of U-238/U-234 and U-238/U-235 were compared to the range of TA-I specific background ratios.

The maximum concentration of the each COC was used in order to provide a conservative estimate of the associated risk. If any nonradiological COCs were above both the TA-I or SNL/NM background screening levels or the USGS background value, all nonradiological COCs were considered in further risk assessment analyses. For radiological COCs that exceeded both the TA-I or SNL/NM background screening levels and, as applicable, were above the range of uranium isotopic ratios, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with USDOE orders.

Radioactive COCs that did not have a background value and were detected above the analytical minimum detectable activity (MDA) were carried through the risk assessment at their maximum levels. This step is performed (rather than carry the below-background radioactive COCs through the risk assessment and then perform a background risk assessment to determine incremental TEDE and estimated cancer risk) to prevent the "masking" of radiological contamination that may occur if on-site background radiological COCs exist in concentrations far enough below the assigned background level. When this "masking" occurs the final incremental TEDE and estimated cancer risk are reduced and, therefore, provide a non-conservative estimate of the potential impact on an on-site receptor. This approach is also consistent with the regulatory approach (40 CFR Part 196, 1994) which sets a TEDE limit to the on-site receptor in excess of background. The resultant radioactive COCs remaining after this step are referred to as background-adjusted radioactive COCs.

Second, if any nonradiological COC failed the initial screening step, the maximum concentration for each nonradiological COC was compared with the relevant action level calculated using methods and equations promulgated in the proposed Resource Conservation and Recovery Act (RCRA) Subpart S (40 CFR Part 264, 1990) and Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989a) documentation. If there are 10 or fewer COCs and each has a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there are more than 10 COCs, the Subpart S screening procedure was skipped.

Third, hazard indices and risk due to carcinogenic effects were calculated using Reasonable Maximum Exposure (RME) methods and equations promulgated in RAGS (USEPA, 1989a). The combined effects of all nonradiological COCs in the soils were calculated. The combined effects of the nonradiological COCs ate their respective background concentrations in the soils were also calculated. The most conservative background concentration between TA-I specific and SNL/NM concentration (minimum value of the 95th UTL or percentile concentration value, as applicable) was used in the risk calculation. For toxic compounds, the combined effects were calculated by summing the individual hazard quotients for each metal into a total Hazard Index. This Hazard Index is compared to the recommended standard of 1. For potentially carcinogenic compounds, the individual risks were summed. The total risk was compared to the recommended acceptable risk range of 10^{-4} to 10^{-6}. For the radioactive COCs, the TEDE was calculated and the corresponding excess cancer risk estimated using USDOE's RESRAD computer code with the background-adjusted radioactive COCs.

II.3.1 Comparison to Background and Action Levels

Nonradioactive ER Site 187 COCs are listed in Table 1, radioactive COCs are listed in Table 2. Both tables show the associated 95th percentile or UTL background levels (SNL/NM, 1996; IT, 1996). Table 3 shows the isotopic uranium ratio comparison to background. Background levels for plutonium and tritium are not applicable because these radionuclides do not occur naturally, or, when due to fallout, at levels detectable by common laboratory analytical instrumentation.

The TA-I background levels have not yet been approved by the USEPA or the NMED, but are the result of statistical analyses of samples collected from background areas within TA-I. USEPA guidance (USEPA, 1989b; 1992a; and 1992b) were followed to arrive at the background levels. The SNL/NM background levels have not yet been approved by the USEPA or the NMED but are the result of a comprehensive study of joint SNL/NM and U.S. Air Force data from the Kirtland Air Force Base (KAFB). The report was submitted for regulatory review in early 1996. The values shown in Table 1 supersede the background values described in an interim background study report (IT, 1994). The background values for aluminum and manganese were determined by the USGS as part of the NURE program (USGS, 1994). Several compounds had maximum measured values greater than background screening levels.

Therefore all nonradiological COCs were retained for further analysis with the exception of lead. The maximum concentration value for lead is 10.6 mg/kg. The USEPA intentionally does not provide any toxicological data on lead and therefore no risk parameter values can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2000 mg/kg (EPA, 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA, 1994a). The maximum concentration value for lead at this site is less than both of those screening values and therefore lead is eliminated from further consideration in this risk assessment. Because organic compounds do not have calculated background values, this screening step was skipped, and all detected organics are carried into the risk assessment analyses.

Because several nonradiological COCs had concentrations greater than their respective TA-I specific or SNL/NM background 95th percentile or UTL, the site fails the background screening criteria and all nonradiological COCs proceed to the proposed Subpart S action level screening procedure. Because the ER Site 187 sample set had more than 10 COCs that continued past the first screening level, the proposed Subpart S screening process was

Table 1. Nonradioactive COCs at ER Site 187 and Comparison to the Background Screening Values.

COC name	Maximum concentration (mg/kg)	TA-I 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable TA-I background screening value?	SNL/NM 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Aluminum	13,900 B	12,055	No	70,000 +	Yes
Antimony	0.45 BJ	0.49	Yes		
Arsenic	4.59	7.7	Yes		
Barium	300 B	654	Yes		
Beryllium	0.69 B	0.57	No	0.80	Yes
Cadmium	2.04 B	0.84	No	1.6	No
Chromium, total	13.2 B	11.7	No	17.3	Yes
Chromium VI	4	54	Yes		
Cobalt	7.93	6.3	No	7.10	No
Copper	12.8 B	10.0	No	25.5	Yes
Lead	10.6	17.3	Yes		
Manganese	358 B	243	No	831 +	Yes
Mercury	0.09 BJ	0.14	Yes		
Nickel	373 B	10.6	No	25.4	No
Selenium	0.86	0.24	No	<1	No^
Silver	4.66	NC	No	2.0	No
Thallium	3.12	1.2	No	<1.1	No
Vanadium	33.8 B	34.9	Yes		
Zinc	44.6 B	50.8	Yes		

NC - not calculated
+ Regional background values from the USGS NURE Program (USGS, 1994).
B - parameter detected in method blank
J - estimated value
^ - uncertainty due to detection limits

Table 2. Radioactive COCs at ER Site 187 and Comparison to the Background Screening Values.

COC name	Maximum concentration (pCi/g)	TA-I 95th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable TA-I background screening value?	SNL/NM 95th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Pu-239/240	31.2	NC	No	NC	No
Pu-238	3.48	NC	No	NC	No
H-3	0.373	NC	No	NC	No
U-238	1.43	0.84	No	1.3	No
U-235	0.151	0.1	No	0.18	Yes
U233/234	1.39	1.03	No	1.6	Yes

NC - not calculated

Table 3. Isotopic Uranium Ratio Comparison to Background Range

COC name	U-238 to U-234 Ratio	TA-I Background U-238 to U-234 Ratio Range	U-238 to U-235 Ratio	TA-I Background U-238 to U-235 Ratio Range	Are isotopic ratios within the range of TA-I background ratios
U-238	1.01	0.804 - 1.253	13.69	8.277 - 23.947	Yes

skipped. All remaining nonradiological COCs must have a Hazard Index value and cancer risk value calculated.

Radioactive contamination does not have pre-determined action levels analogous to the proposed Subpart S and therefore this step in the screening process is not performed for radionuclides.

II.3.2 Identification of Toxicological Parameters

Tables 4 and 5 show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs. Dose conversion factors (DCFs) used in determining the excess TEDE values for the individual pathways were the default values provided in the RESRAD computer code as developed in the following:

- For ingestion and inhalation, DCFs are taken from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (USEPA, 1988a).
- The DCFs for surface contamination (contamination on the surface of the site) were taken from USDOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public* (USDOE, 1988).
- The DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in, *Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil* (Health Physics 28:193-205) (Kocher, D.C., 1983), and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu, C., et al., 1993a).

II.3.3 Exposure Assessment and Risk Characterization

Section II.3.3.1 describes the exposure assessment for this risk assessment. Section II.3.3.2 provides the risk characterization including the Hazard Index value and the excess cancer risk for both potential nonradiological COCs and associated background; industrial and residential land-uses. The TEDE and estimated cancer risk are provided for the background-adjusted radiological COCs; industrial and residential land-uses.

II.3.3.1 Exposure Assessment

Appendix 1 shows the equations and parameter values used in the calculation of intake values and the subsequent Hazard Index and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations are based on RAGS (USEPA, 1989a). The parameter values are based on information from RAGS (USEPA, 1989a) as well as other USEPA guidance documents and reflect the RME approach advocated by RAGS (USEPA, 1989a). For radionuclides, the coded equations provided in the RESRAD computer code were used to estimate the excess TEDE and cancer risk for the individual exposure pathways. Further discussion of this

Table 4. Nonradioactive Toxicological Parameter Values for ER Site 187 COCs

COC name	RfD_o (mg/kg/d)	RfD_{inh} (mg/kg/d)	Confidence	SF_o (kg-d/mg)	Sf_{inh} (kg-d/mg)	Cancer Class
Aluminum	1	--	Est.	--	--	--
Antimony	0.0004	--	L	--	--	D
Arsenic	0.0003	--	M	1.5	15.1	A
Barium	0.07	0.000143	M	--	--	D
Beryllium	0.005	--	L	4.3	8.4	B2
Cadmium	0.0005	0.0000571	H	--	6.3	B1
Chromium, total*	1	0.000000571	L	--	--	D
Chromium VI	0.005	--	L	--	42	A
Cobalt	0.06	--	--	--	--	--
Copper	0.04	--	Est.	--	--	D
Manganese	0.005	0.0000143	--	--	--	D
Mercury	0.0003	0.0000857	--	--	--	D
Nickel	0.02	--	--	--	--	D
Selenium	0.005	--	H	--	--	D
Silver	0.005	--	--	--	--	D
Thallium	--	--	--	--	--	D
Vanadium	0.007	--	Heast	--	--	D
Zinc	0.3	--	M	--	--	D
Benzene	--	0.00171	--	0.029	0.029	A
Toluene	0.2	0.14	M	--	--	D
Xylene	2	--	M	--	--	D
Dimethyl phthalate	10	--	--	--	--	D
Fluoranthene	0.04	--	L	--	--	D
Phenanthrene	--	--	--	--	--	D
Pyrene	0.03	--	L	--	--	D
bis(2-Ethylhexyl) phthalate	0.02	--	--	0.014	--	B2
PCBs (total aroclors)	--	--	--	7.7	--	B2

RfD_o - oral chronic reference dose in mg/kg-day
RfD_{inh} - inhalation chronic reference dose in mg/kg-day
Confidence - L = low, M = medium, H = high, Est. - estimated
Heast - Heast table from USEPA 1996b
SF_o - oral slope factor in $(mg/kg\text{-}day)^{-1}$

SF_{inh} - inhalation slope factor in $(mg/kg\text{-}day)^{-1}$
^ EPA weight-of-evidence classification system for carcinogenicity:
A - human carcinogen
B1 - probable human carcinogen. Limited human data are available
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen
D - not classifiable as to human carcinogenicity
E - evidence of noncarcinogenicity for humans
-- information not available
* total chromium assumed to be chromium III because chromium VI is calculated separately

Table 5: Radiological Toxicological Parameter Values for ER Site 187 COCs

COC name	SF_{ev} (g/pCi-yr)	SF_o (1/pCi)	SF_{inh} (1/pCi)	Cancer Class^
Pu-239/240	1.3E-11	3.2E-10	2.8E-08	A
Pu-238	1.9E-11	3.0E-10	2.7E-08	A
H-3	0	7.2E-14	9.6E-14	A

Sf_{ev}- external volume exposure slope factor (risk/yr per pCi/g)
SF_o - oral (ingestion) slope factor (risk/pCi)
SF_{inh} - inhalation slope factor (risk/pCi)
^ EPA weight-of-evidence classification system for carcinogenicity:
A - human carcinogen
B1 - probable human carcinogen. Limited human data are available
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen
D - not classifiable as to human carcinogenicity
E - evidence of noncarcinogenicity for humans

process is provided in Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu, C., et al., 1993).

Although the designated land-use scenario is industrial for this site, the risk and TEDE values for a residential land-use scenario are also presented. These residential risk and TEDE values are presented only to provide perspective on the potential for risk to human health under the more restrictive land-use scenario.

II.3.3.2 Risk Characterization

Table 6 shows that for the nonradioactive COCs, the Hazard Index value is 0.2 and the excess cancer risk is 6×10^{-6} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust and volatile inhalation for the nonradioactive COCs. Table 7 shows that for the ER Site 187 associated background constituents, the Hazard Index is 0.08 and the excess cancer risk is 5×10^{-6} for the designated industrial land-use scenario.

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. The incremental TEDE for the industrial land-use scenario is 1.8 mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an incremental TEDE of 15 mrem/yr (40 CFR Part 196, 1994) for the probable land-use scenario (industrial in this case); the calculated dose value for ER Site 187 for the industrial land-use is well below this standard.

For the residential land-use scenario, the Hazard Index value increases to 6 and the excess cancer risk is 8×10^{-5}. The number presented included exposure from soil ingestion, dust and volatile inhalation and plant uptake. Although USEPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, NM, to be eroded and, subsequently, for dust to be present even in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 7 shows that for the ER Site 187 associated background constituents, the Hazard Index increases to 4 and the excess cancer risk is 7×10^{-5}.

For the radioactive COCs, the incremental TEDE for the residential land-use scenario is 8.9 mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an excess TEDE of 75 mrem/yr (40 CFR Part 196, 1994) for a complete loss of institutional controls (residential land-use in this case); the calculated dose values for ER Site 187 for the residential land-use is well below this standard. It should also be noted that, consistent with the proposed guidance (40 CFR Part 196, 1994), ER Site 187 should be eligible for unrestricted radiological release as the residential scenario resulted in an incremental TEDE to the on-site receptor of less than 15 mrem/yr.

Table 6. Nonradioactive Risk Assessment Values for ER Site 187 COCs.

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Aluminum	13,900 B	0.01	--	0.05	--
Antimony	0.45 BJ	0.00	--	0.02	--
Arsenic	4.59	0.01	3E-6	0.26	5E-5
Barium	300 B	0.00	--	0.04	--
Beryllium	0.69 B	0.00	1E-6	0.00	5E-6
Cadmium	2.04 B	0.00	8E-10	1.67	1E-9
Chromium, total*	13.2 B	0.00	--	0.00	--
Chromium VI	4	0.00	1E-8	0.00	2E-8
Cobalt	7.93	0.00	--	0.00	--
Copper	12.8 B	0.00	--	0.06	--
Manganese	358 B	0.07	--	3.17	--
Mercury	0.09 BJ	0.00	--	0.16	--
Nickel	373 B	0.02	--	0.07	--
Silver	4.66	0.00	--	0.19	--
Selenium	0.86	0.00	--	0.30	--
Thallium	3.12	--	--	--	--
Vanadium	33.8 B	0.00	--	0.03	--
Zinc	44.6 B	0.00	--	0.08	--
Benzene	1.3	0.07	2E-06	0.10	2E-5
Toluene	0.00746 J	0.00	--	0.00	--
Xylene	0.0013 J	0.00	--	0.00	--
Dimethyl phthalate	0.799 J	0.00	--	0.00	--
Fluoranthene	2.42 J	0.00	--	0.00	--
Phenantherene	0.308 J	--	--	--	--
Pyrene	2.16 J	0.00	--	0.00	--
bis(2-Ethylhexyl) phthalate	0.336 B	0.00	2E-09	0.00	7E-9
PCBs (total aroclors)	0.0554	0.00	2E-07	0.00	7E-7
TOTAL		**0.2**	**6E-6**	**6**	**8E-5**

B - parameter detected in method blank
J - estimated value
-- information not available
* total chromium assumed to be chromium III because chromium VI is calculated separately

Table 7. Nonradioactive Risk Assessment Values for ER Site 187 Background Constituents.

Constituent Name	Background concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land- Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Aluminum	12,055	0.01	--	0.05	--
Antimony	0.49	0.00	--	0.02	--
Arsenic	5.6	0.02	4E-06	0.32	6E-05
Barium	200	0.00	--	0.03	--
Beryllium	0.57	0.00	1E-06	0.00	5E-06
Cadmium	0.84	0.00	3E-10	0.69	5E-10
Chromium, total*	11.7	0.00	--	0.00	--
Chromium VI**	11.7	0.00	3E-8	0.01	4E-8
Cobalt	6.3	0.00	--	0.00	--
Copper	10.0	0.00	--	0.04	--
Manganese	243	0.05	--	2.15	--
Mercury	0.14	0.00	--	0.24	--
Nickel	10.6	0.00	--	0.00	--
Selenium	0.24	0.00	--	0.08	--
Silver	2.0	0.00	--	0.08	--
Thallium	<1.1	--	--	--	--
Vanadium	34.9	0.00	--	0.03	--
Zinc	50.8	0.00	--	0.09	--
TOTAL		**0.08**	**5E-6**	**4**	**7E-5**

-- information not available
J - estimated value
* total chromium assumed to be chromium III because chromium VI is calculated separately

** chromium background concentration assumed to be chromium III (most conservative - lowest UTL), risk calculated in terms of chromium VI (consistent with Table 6)

The cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (USEPA, 1989a).

II.4 Step 6 Comparison of Risk Values to Numerical Standards.

The risk assessment analyses considered the evaluation of the potential for adverse health effects for both an industrial land-use scenario, which is the designated land-use scenario for this site, and also a residential land-use scenario.

For the industrial land-use scenario, the Hazard Index calculated is 0.2; this is much less than the numerical standard suggested in RAGS (USEPA, 1989a) of 1. The excess cancer risk is estimated at 6×10^{-6}. In RAGS, the USEPA suggests that a range of values (10^{-6} to 10^{-4}) be used as the numerical standard; the value calculated for this site is in the low end of the suggested acceptable risk range. Therefore, for an industrial land-use scenario, the Hazard Index risk assessment values are significantly less than the established numerical standards and the excess cancer risk is in the low end of the acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.08. The excess cancer risk is estimated at 5×10^{-6} . Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and discussed in the text. The incremental Hazard Index is 0.1 and the incremental cancer risk is 1.2×10^{-6} for the industrial land-use scenario.

For the radioactive components of the industrial land-use scenario, the calculated incremental TEDE is 1.8 mrem/yr, which is significantly less than the numerical standard of 15 mrem/yr suggested in the draft USEPA guidance. The incremental excess cancer risk estimate is 5×10^{-6}.

For the residential land-use scenario, the calculated Hazard Index is 6, which is above the numerical guidance. The excess cancer risk is estimated at 8×10^{-5}; this value is in the upper end of the suggested acceptable risk range. The hazard index for the associated background for the residential land-use scenario is 4. The excess cancer risk is estimated at 7×10^{-5}. For the residential land-use scenario, the incremental Hazard Index is 2.4 and the

incremental cancer risk is 1×10^{-5}. The incremental TEDE from the radioactive components is 8.9 mrem/yr, which is significantly less than the numerical standard of 75 mrem/yr suggested in the draft USEPA guidance. The associated incremental excess cancer risk estimate is 2×10^{-5}. The potential pathways considered for this calculation includes both soil ingestion, dust inhalation and plant uptake.

II.5 Step 7 Uncertainty Discussion

The conclusion from the risk assessment analysis is that the potential effects caused by potential nonradiological COCs on human health are small compared to established numerical standards for the industrial land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated background indicate small contribution of risk from the nonradiological COCs when considering the industrial land-use scenario.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the industrial land-use scenario, are well within proposed standards (40 CFR Part 196, 1994) and are a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1989).

The potential effects on human health, for the nonradiological COCs, are greater when considering the residential land-use scenario. Incremental risk between potential nonradiological COCs and associated background also indicates a greater contribution of risk from the nonradiological COCs. The increased effects on human health are primarily the result of including the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because TA-I is an industrial site and is designated as industrial land-use area (USDOE, 1996), the likelihood of significant plant uptake in this area is highly unlikely. The uncertainty in this conclusion is also considered to be small.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the residential land-use scenario, is well within proposed standards (40 CFR Part 196, 1994) and is a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1989).

Because of the location, history of the site and the future land-use (USDOE, 1996), there is low uncertainty in the land-use scenario and the potentially

affected populations that were considered in making the risk assessment analysis. Because the COCs are found in subsurface soils and because of the location and physical characteristics of the site, the exposure pathways relevant to the analysis are conservative. For example, considering the industrial land-use scenario, the soil ingestion pathway results are very conservative as a worker contacting the soil at depth would be likely involved in construction and would contact the soil for only a short time instead of 30 years.

This is particularly applicable in application to the radiological COCs. Although the sewer system constitutes a small portion of all of TA-I, and it is buried 2.5 to 16 feet below ground surface, it was assumed that the radiological COCs were present throughout all of TA-I (254 acres) and that they were uniformly distributed from ground surface to 13.5 feet below ground surface, thus, not accounting for the 2.5 feet of clean cover over the sewer system.

An RME approach was used to calculate the risk assessment values, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs and minimum value of the 95th UTL or percentile background concentration value, as applicable, of background concentrations associated with the COCs were used to provide conservative results.

Table 4 shows the uncertainties (confidence) in the nonradiological toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1996b) and Integrated Risk Information System (IRIS) (USEPA, 1988, 1994b) databases. Where values are not provided, information is not available from HEAST, IRIS, or USEPA regions. The constituents without toxicological parameters have low concentrations and are judged to be insignificant contributors to the overall risk. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The nonradiological risk assessment values are low for the industrial land-use scenario compared to the established numerical standards. Though the residential land-use Hazard Index is above the numerical standard, it has been determined that future land-use at this locality will not be residential (USDOE, 1996). The radiological incremental TEDE is a small fraction of estimated background TEDE for both the industrial and residential land-use scenarios and both are well within proposed standards (40 CFR Part 196, 1994). The overall uncertainty in all of the steps in the risk assessment

process is therefore considered insignificant with respect to the conclusion reached.

III. Summary

The TA-I Sanitary Sewer System, ER Site 187, had relatively minor contamination consisting of some inorganic and organic nonradioactive and radioactive compounds. Because of the location of the site on KAFB, the designated industrial land-use scenario (USDOE, 1996) and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust and volatile inhalation for chemical constituents and soil ingestion, dust and volatile inhalation, and direct gamma exposure for radionuclides. These exposure pathways are very conservative as a worker contacting the soil at depth would likely be involved in construction and would contact the soil for only a short time instead of 30 years.

The residential land-use scenario includes the soil ingestion, inhalation, and plant uptake exposure pathways. Because the small amount of contamination present is below ground surface, the potential for exposure from soil ingestion and inhalation of surface dust is not significant. Likewise, plant uptake will generally occur near surface. Because the site is designated as industrial (USDOE, 1996) and the residential land-use scenario is presented to only provide perspective, the stated exposure pathways were included but provide a conservative risk assessment.

Using conservative assumptions and employing a RME approach to the risk assessment, the calculations for the nonradiological COCs show that for the industrial land-use scenario the Hazard Index (0.2) is significantly less than the accepted numerical guidance from the USEPA. The estimated cancer risk (6×10^{-6}) is in the low end of the suggested acceptable risk range. The incremental Hazard Index is 0.1 and the incremental cancer risk is 1.2×10^{-6} for the industrial land-use scenario. Incremental risk calculation indicate that insignificant contribution to risk from the COCs considering an industrial land-use scenario.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than USEPA guidance values; the estimated incremental TEDE is 1.8 mrem/yr for the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr (for industrial) in draft USEPA guidance. The corresponding incremental estimated cancer risk value is 5×10^{-6} for the industrial land-use scenario.

The calculations for the nonradiological COCs show that for the residential land-use scenario the Hazard Index (6) is above the accepted numerical guidance from the USEPA. The estimated cancer risk (8×10^{-5}) is also in the upper end of the suggested acceptable risk range. The majority of the risk is associated with the inclusion of the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because TA-I is an industrial site, the likelihood of significant plant uptake in this area is highly unlikely. Also, the contamination occurs at depth, below typical plant root zones. For the residential land-use scenario, the incremental Hazard Index is 2.4 and the incremental cancer risk is 1×10^{-5}. Contribution of risk from the COCs was evident considering residential land-use, due to the plant uptake exposure pathway, but future use will be restricted to industrial land-use.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than USEPA guidance values; the estimated incremental TEDE is 8.9 mrem/yr for the residential land-use scenario. This value is much less than the numerical guidance of 75 mrem/yr (for residential) in draft USEPA guidance. The corresponding incremental estimated cancer risk value is 2×10^{-5} for the residential land-use scenario.

The uncertainties associated with the calculations are considered small relative to the conservativeness of the risk assessment analysis. We therefore conclude that this site does not have significant potential to affect human health under either an industrial or a residential land-use scenario.

Ecological Risk Assessment

It is unlikely that activities or COCs at ER Site 187 have or will have significant impact to ecological risk. TA-I is an industrial complex and has been heavily disturbed by humans for over 50 years. Given the amount of known and potential human intrusion, a great diversity or abundance of nonhuman species has not occurred and is unlikely. Much of the relevant ecological information for TA-I can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM, 1992).

IV. References

40 CFR Part 264, 1990, Code of Federal Register, U.S. Government, EPA Proposed Corrective Action Rule For Solid Waste Management Units (55 FR 30798; July 27, 1990.

40 CFR Part 196, 1994, Code of Federal Register, Radiation Site Cleanup Regulation, rough draft, U.S. Government 1994.

IT, 1994, Background Concentrations of Constituents of Concern to the Sandia National Laboratories/New Mexico, Environmental Restoration Project, Phase II Interim Report, IT Corporation, Albuquerque, New Mexico.

IT, 1996, Background Concentrations of Constituents of Concern to the Sandia National Laboratories/New Mexico, Environmental Restoration Project and the Kirtland Air Force Base Installation Restoration Program, IT Corporation, Albuquerque, New Mexico.

Kocher, D.C. 1983, "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil," *Health Physics* 28:193-205.

NCRP, 1987, Exposure of the Population in the United States and Canada from Natural Background Radiation, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

Sandia National Laboratories/New Mexico (SNL/NM), 1992. "Site Development Plan." Sandia National Laboratories, Albuquerque, New Mexico. October 1992.

Sandia National Laboratories/New Mexico (SNL/NM), 1996, Technical Area I RCRA Facility Investigation Data Evaluation Report, Background Soils Investigation, Environmental Restoration Project, Sandia National Laboratories, U.S. Department of Energy, Albuquerque Operations Office, June 1996.

USDOE, 1988, External Dose-Rate Conversion Factors for Calculation of Dose to the Public, USDOE/EH-0070, Assistant Secretary for Environment, Safety and Health, Washington, D.C.

USDOE and USAF, 1996, Workbook: Future Use Management Area 2, Sectors 2E and 2G, Areas I-V, Future Use Logistics and Support Working Group, March 1996.

USEPA, 1988, Availability of the Integrated Risk Information System (IRIS). 53 Federal Register 20162.

USEPA, 1988a, Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C.

USEPA, 1989a, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

USEPA, 1989b, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities--Interim Final Guidance. Waste Management Division. USEPA. February 1989.

USEPA, 1991, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B), U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

USEPA, 1992a, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities--Addendum to Interim Final Guidance. Office of Solid Waste Permits and State Programs Division. USEPA. July 1992.

USEPA, 1992b, Statistical Methods for Evaluating the Attainment of Cleanup Standards. Volume 3: Referenced-Based Standards for Soils and Solid Media. Office of Policy, Planning and Evaluation. USEPA. December 1992.

USEPA, July 14, 1994a, memorandum from Elliott Laws, Assistant Administrator to Region Administrators I-X, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Active Facilities.

USEPA 1994b, Integrated Risk Information System (IRIS) Data File, U.S. Department of Health and Human Services, National Library of Medicine Toxicology Data Network (TOXNET), Bethesda, Maryland.

USEPA, 1996a, draft Region 6 Superfund Guidance, Adult Lead Cleanup Level.

USEPA, 1996b, Health Effects Assessment Summary Tables (HEAST)-Published quarterly by the Office of Research and Development and Office of Solid Waste and Emergency Response. NTIS#PB 91-921100.

U.S. Geological Survey (USGS), 1994, National Geochemical Data Base: National Uranium Resource Evaluation Data for the Contiguous United

States, U.S. Geological Survey Digital Data Series Dds-18-a, Washington, D.C.

Yu, C., et al., 1993, Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0. Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

Yu, C., et al., 1993a, Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil, ANL/EAIS-8, Argonne National Laboratory, Argonne, Illinois.

APPENDIX 1.

Sandia National Laboratories Environmental Restoration Program

EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

BACKGROUND

Sandia National Laboratories (SNL) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM ER sites have similar types of contamination and physical settings, SNL believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the USEPA Region VI and NMED, SNL proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all Environmental Restoration sites exist within the boundaries of the Kirtland AFB. Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/ER draft Environmental Assessment (DOE, 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM ER sites. At this time, all SNL/NM ER sites have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based on a residential land use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index, risk and dose values. EPA (EPA, 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water;
- Ingestion of contaminated soil;

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products;
- Ingestion of contaminated surface water while swimming;
- Dermal contact with chemicals in water;
- Dermal contact with chemicals in soil;
- Inhalation of airborne compounds (vapor phase or particulate), and;
- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based on the location of the SNL ER sites and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM ER sites, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL, 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land use scenarios, SNL/NM ER has therefore excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM ER site:

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products; and
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based on this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to

not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Table 1. Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA, 1989a and 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL, 1993). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for industrial, recreational, and residential scenarios, based on EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL, 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., Hazard Quotient/Index, excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \quad (1)$$

where

- C = contaminant concentration (site specific);
- CR = contact rate for the exposure pathway;
- EFD = exposure frequency and duration;
- BW = body weight of average exposure individual;
- AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or hazard index) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 10^{-4} to 10^{-6}. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the Hazard Index) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard Hazard Index of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA, 1989) and the RESRAD Manual (ANL, 1993). Table 2 shows the default parameter values suggested for used by SNL at ER sites, based on the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are

Table 2. Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (d/y)	***	***	***
Exposure duration (y)	30[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	56[a,b]	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (=70 y x 365 d/y) for noncarcinogenic compounds (=ED x 365 d/y)	25550[a] 10950	25550[a] 10950	25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/d[c]	6.24 g/y[d]	114 mg-y/kg-d[a]
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	146[d]	5475[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (L/d)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	chemical specific	chemical specific	chemical specific

*** The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 h/d for 250 d/y; for the recreational land use, a value of 2 hr/wk for 52 wk/y is used (EPA, 1989b); for a residential land use, all contact rates are given per day for 350 d/y.

[a] RAGS, Vol 1, Part B (EPA, 1991).

[b] Exposure Factors Handbook (EPA, 1989b)

[c] EPA Region VI guidance.

[d] For radionuclides, RESRAD (ANL, 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e] Dermal Exposure Assessment, 1992.

suggested for use for the various exposure pathways based on the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land-use, SNL will provide risk parameter values based on a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on Sandia ER sites. The parameter values are based on EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

References

ANL, 1993, Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, IL.

DOE, Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories/New Mexico, US. Dept. of Energy, Kirtland Area Office, 1996.

EPA, 1989a, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, EPA/540-1089/002, US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1989b, Exposure Factors Handbook, EPA/600/8-89/043, US Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, D.C.

EPA, 1991, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B), EPA/540/R-92/003, US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1992, Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, Office of Research and Development, Washington, D.C.

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ADDITIONAL /SUPPORTING DATA

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